PROCEEDINGS

OF THE

ARCTIC TRANSPORTATION CONFERENCE

YELLOWKNIFE, N.W.T.

DECEMBER 8 & 9, 1970

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MINISTRY OF TRANSPORT

AND THE

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

VOLUME - 3

(English Version)

CONFERENCE CO-CHAIRMEN: Hon. Jean Chrétien, P.C., M.P.
Hon. Don Jamieson, P.C., M.P.

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Thirty-four background papers were prepared to provide a body of information and reference material in advance of the discussions at the 1970 Arctic Transportation Conference in Yellowknife NWT, December 8 & 9 1970. This collection of papers as well as other papers presented at the conference are published in volumes 2 and 3 of the proceedings.

Volume 1 contains the proceedings of the opening, second and the final plenary sessions. Volume 1 also contains the speeches at the Conference banquet, a short summary of all papers presented, biographicial sketches of panele members, a list of delegates and discussions at all sessions. Generally speaking, discussion is reported verbatim but in several instances there have been minor alterations and deletions for the sake of brevity and clarity and because of recording difficulties. Papers given by government employees did not represent official policy but were prepared to further discussion of different courses of planning and action.

FOREWORD

THE THEME:

"ARCTIC TRANSPORT IN THE 1970's"

Transportation plays a crucial role in the development of a country. The building of the CPR helped unite Canada. What this generation does in the Arctic can have equally important and long-lasting results. Our objective is a transportation system that contributes to the orderly social and economic development of the area, compatible with the protection of the environment.

The many agencies, commercial interests and general users of transportation services will have a major part to play in helping achieve this objective. Previously, these interested parties had little opportunity for coordinated discussion of their problems. The Arctic Transportation Conference in Yellowknife December 8 and 9, 1970 was held to provide this opportunity.

In presenting this record of the Yellowknife Conference, the Ministry of Transport and the Department of Indian Affairs and Northern Development wish to express their joint appreciation of the work contributed by all concerned.

TABLE OF CONTENTS

NOTE: This table contains the complete list of contents for all three volumes of the Arctic Transportation Conference Proceedings.

TABLE OF CONTENTS

VOLUME 1 (cont'd.)

VOLUME 2

TABLE OF CONTENTS

VOLUME 2 (cont'd.)

TABLE OF CONTENTS

VOLUME 2 (cont'd.)

VOLUME 3

TABLE OF CONTENTS
VOLUME 3 (cont'd)

TABLE OF CONTENTS
VOLUME 3 (cont'd.)

VOLUME 3

SECTION 1 - TRANSPORTATION: PEOPLE AND THE ENVIRONMENT

CHAIRMAN: G. C. Butler

PANELISTS: J. K. Naysmith

R. A. Hemstock

A. Stevenson

W. A. Fuller

"The people are the most
important element in a nation".

Mencius

TRANSPORTATION: PEOPLE AND THE ENVIRONMENT
A Legislative Base

BY: J.K. NAYSMITH
Department of Indian Affairs & Northern Development

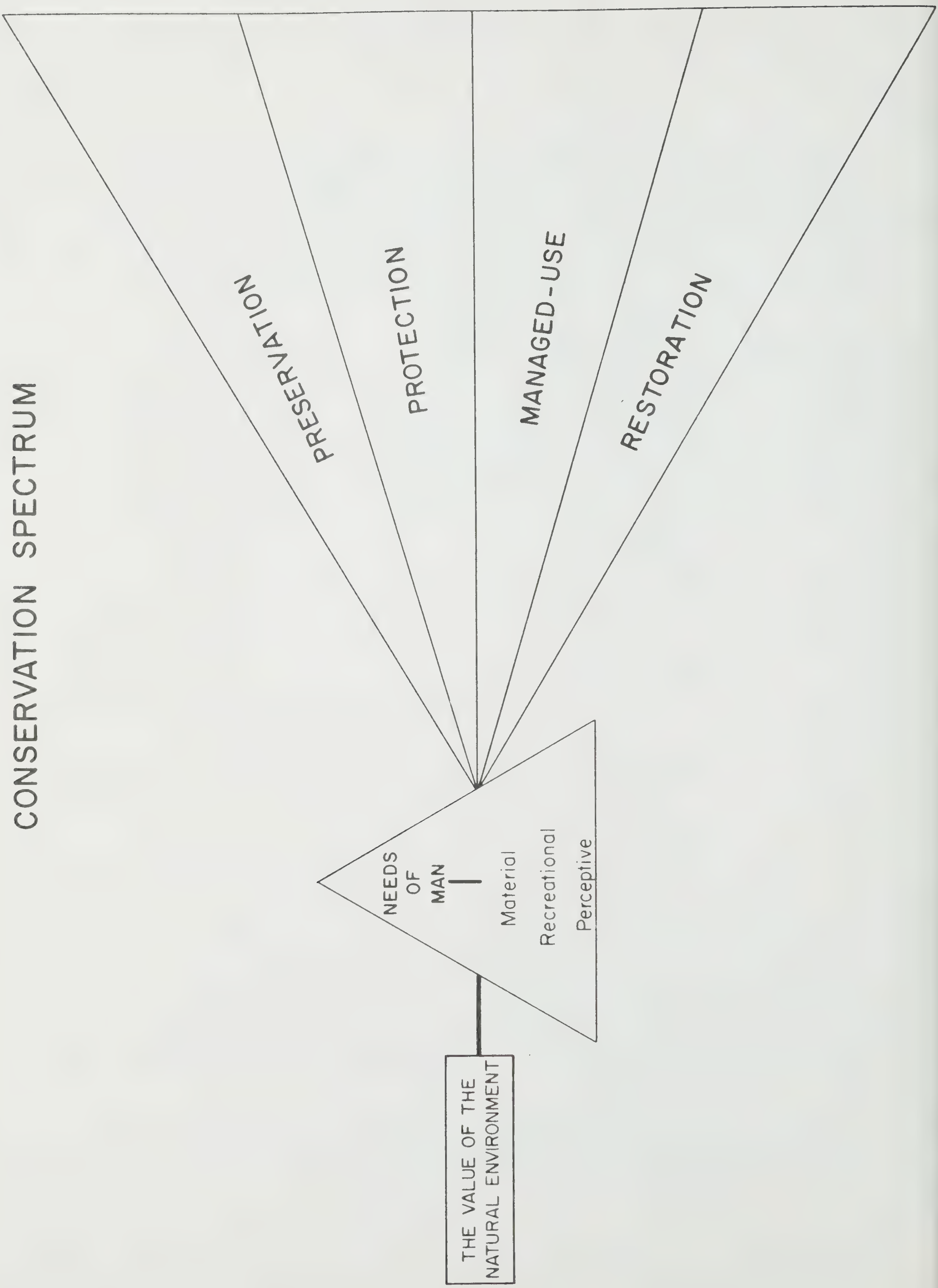
A well founded conservation program must be based upon a package of environmental legislation which goes beyond the simple consideration of the various natural elements of air, land and water. Rather the legislative base must contain principles which reflect the real value of the natural environment expressed as the needs of mankind. These needs can be broken down into three categories: material, recreational and perceptive.

If one considers, as in figure 1, the value of the natural environment to be a beam of light passing through a prism comprising the three needs of mankind, the spectrum thus formed consists of four elements. These four elements of preservation, protection, managed-use and restoration may be considered the principal components of conservation. The concept of conservation thus conceived it is then necessary to reconcil man's needs in terms of those elements. It is this reconciliation which provides the guidelines for developing a solid and operable legislative base.

Elements	Guidelines
Preservation	designate areas for recreation aesthetic, historic, wildlife, archaeological, scientific purposes.
Protection	maintain quality of the biosystem and prevent degradation of life sustaining elements.
Managed-use	minimize disturbance to the resource-base as a result of industrial utilization.
Restoration	reclaim the resource-base following natural or man-made disturbances.

From the nature of the guidelines it is evident that no single piece of legislation will encompass all the elements. It is also apparent that none of man's needs can be met by legislation covering just one of the elements. For example, the material needs require consideration of the guidelines encompassing the restoration, managed-use and protection elements. Similarily legislation, derived from all four guidelines, must respond to man's perceptive needs.

Having discussed the process by which an environmental program can be designed let us turn for a moment to the question of mankind's needs.


CONSERVATION SPECTRUM
PRESERVATION
PROTECTION
MANAGED-USE
RESTORATION
NEEDS OF MAN
Material
Recreational
Perceptive
THE VALUE OF THE NATURAL ENVIRONMENT

With respect to material requirements, if we consider the environment to mean all of the renewable and non-renewable resources then its value to man needs little discussion. To a large degree economic development is based upon increasing utilization of the resource-base and in the process society becomes progressively more dependent upon the extractive industries for its material comfort.

There is the even more direct relationship existing between the land and the native people who derive a livelihood from hunting and trapping.

While economic growth and natural resource utilization have become synonymous there has also been an increased awareness of the inherent recreational value of the natural setting. More leisure time, greater mobility, higher incomes and increasing urban tension have resulted in a growing use of land and water for recreational pursuits.

The third category, perceptive needs, is a consideration of the requirements of man beyond the physical. The mental well-being of the individual is in part assured by the recognition of the aesthetic quality inherent in the natural environment. More than this however there is also the uplifting influence emanating from the natural setting and the knowledge that it does exist. This growing awareness of the natural setting is a manifestation of a shifting sense of values apparently correlated to the increasing impact of technology upon the environment.

Turning to the conservation spectrum and the guidelines for legislation we have the following.

At one end of the spectrum are the elements of managed-use and restoration of the resource-base. Here the emphasis is on utilization but under conditions which make the maximum use of the particular resource being harvested and minimize disturbance of other resources during the harvesting and processing phases. For example, where land or water is needed in order to carry out an industrial operation, regulatory control can be imposed upon the user as conditions for acquiring the rights to the use of the land or water.* The object is to minimize disturbance to the resource-base while accepting the fact that if the natural resources are used, some degree of disturbance is unavoidable.

The next element in the conservation spectrum is the protection of the biosystem to ensure the future material needs of mankind. Here it is a question of maintaining the quality of the environment for purposes of self-preservation. Unlike the element of managed-use where some degree of distrubance is acceptable, here the

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* An example of this kind of legislation is the Amendment to the Territorial Lands Act (1970) which provides for the Land-Use Regulations.

emphasis is on prevention.** With the protection element of conservation, the object is the elimination of the possibility of degradation because of the serious ramifications which arise from not achieving that goal. Included in this category would be pollution of the seas by toxic materials which could effectively eliminate marine plant and animal life. In this instance, legislation must be of a preventive nature calling for high standards of ship construction and marine technology.

The fourth element of conservation is the preservation of particular segments of the resource-base. Here the question is one of preserving areas of unique aesthetic and recreational value. With increasing industrial use of the natural resources, this element of the spectrum must be a dynamic one. Although the other elements tend to mitigate the detrimental effects of resource use, the preservation element must be a positive force in maintaining, through parks and wilderness areas, the intrinsic values of the land for the wellbeing of the individual.

To complete the conservation spectrum, and as an adjunct to the preservation element, is the need to designate certain areas as being of historic and archaeological importance and to allocate others for scientific research. Such areas although relatively small should be maintained in an unmodified state. An example, of this aspect of conservation would be the areas of ecological uniqueness designated by the International Biological Program.

The type of regulatory control required to minimize damage to the land described in the previous section was not possible given the legislation existing in 1969. The Territorial Lands Act (chapter 263 Revised Statutes of Canada 1952, as amended) provided authority for the disposition of Crown Land in the Territories through sale and surface leases but did not cover the required elements of protection and controlled use.

In view of this, an amendment to the Territorial Lands Act received first reading in the spring of 1970. On June 22, 1970, it was passed by the House of Commons and on June 26, 1970, Bill C-212, an Act to amend the Territorial Lands Act received Royal Assent.

The purpose of the amendment is to provide a legislative base for the promulgation of regulations which will provide a measure of control over the types and methods of northern resource exploration, development and restoration procedures.

** For example the Act to Prevent Pollution to Arctic Waters.

Space does not permit a full discussion of the new legislation however the more pertinent Sections of the Amendment are as follows:

> *Section 18(ia) make regulations respecting the protection, control and use of the surface of territorial lands.*
>
> *Section 3A. Where he deems it necessary for the protection of the ecological balance or physical characteristics of any area in the Yukon or the Northwest Territories, the Governor in Council may, after consultation with the Council of the Yukon Territory or the Council of the Northwest Territories . . . set apart and appropriate any territorial lands in that area as a land management zone.*
>
> *Section 3B. The governor in Council may, after consultation with the Council of the Yukon Territory or the Council of the Northwest Territories . . . make regulations respecting:*
>
> *a) the protection, control and use of the surface of land in a land management zone; and*
>
> *b) the issue of permits for the use of the surface of land in a land management zone, the terms and conditions of such permits and the fees therefor.*

According to Section 18A all regulations referred to in 18(ia) and 3B (a) and the orders setting apart Land Management Zones must be published in the Canada Gazette <u>prior</u> to promulgation so that "a reasonable opportunity shall be afforded to all interested persons to make representations to the Minister with respect thereto."

The regulations (which should be appearing in the Canada Gazette about the time this article is published) are divided into 3 parts.

PART I	General Regulations (which will apply throughout the territories)
PART II	Land Management Zones (regulations applicable within the declared zones.)
PART III	Procedures and Appeals.

Each part is further divided into the following subject areas:

PART I - General Regulations

Application - Campsites - Fuel and Supply storage - Insecticides - Wildlife - Stream Crossings - Explosives - Excavations - Highways and Roads - Works and Facilities - Surveys and Monuments - Removal of Buildings - Land Clearing - Land-Use Operations North of the 66th Parallel - Restoration

PART II - Land Management Zones

Application - Permits - Land Division and Plans - Application for a Land Use Permit - Inspection Before Issue of Permit - Issue of Land-Use Permit - Terms and Conditions of Permits - Fees - Reports - Final Plan- Guarantee Deposit - Cancellation of Land Use Permit - Responsibility

PART III - Procedures and Appeals

Powers of Inspector - Appeals - Offences - Notice

The effectiveness of the land management program is wholly dependent upon the way in which the instruments of management, that is the zones, the regulations, the permits and their accompanying stipulations are developed and used. The process involves several steps.

(a) The collection of available data and the designation of geographic areas which reflect various values of the land. Such areas would include those of:

(i) economic and social significance to native peoples (e.g. hunting and trapping grounds)
(ii) recreational and aesthetic value
(iii) wildlife and wildlife habitat (e.g. breeding and nesting grounds)
(iv) ecological uniqueness
(v) historic, archaeological and scientific significance.

All areas for each category are plotted on a separate transparency or overlay sheet.

Obviously the success of this step is dependent upon the thoroughness of the consultation process. Each category requires discussion with quite different groups and must include the native people, the scientific and university community, and agencies in all levels of government.

(b) The preparation of maps depicting possible areas, and nature, of future industrial activity based upon available data including forest inventory maps, geology and mineral occurrence maps, and maps of potential oil and gas lands.

(c) The identification of a series of geographic zones called Land-Management Zones. These zones are formed by superimposing the transparencies depicting land value areas (a) on the base maps showing region of industrial activity (b).

(d) For each Land-Management Zone the preparation of a "Surface-Sensitivity" map which in effect represents an inventory of the ecological characteristics of that zone. In part these maps are produced from airphoto interpretation of terrain conditions including consideration of such variables as topography, drainage, soil moisture conditions and vegetative cover. Three or four degrees of sensitivity are defined and the Land-Management Zone sub-divided into areas, coded as to sensitivity to disturbance, and mapped on overlays.

(e) The setting of a series of stipulations for land-use operations. This is done by collating the transparency sheets in (d) with the Land-Management Zones (c) keeping in mind the specific factors (i.e. recreation, wildlife habitat etc.) for each zone as described in (a). In setting stipulations the same kind of consultation is required here as in (a).

(f) The implementation of a research program to back up the regulatory program in order to appraise more accurately the actual extent and nature of the damage resulting from land-use operations. In this way stipulations that are either too permissive or too restrictive can be modified so that they will respond more accurately to the need. To this end the Water, Forests and Land Division began in 1969 the ALUR (Arctic Land-Use Research) program.

An Illustration of Stipulations

Each permit issued for a land-use operation within a land management zone will have attached to it, in addition to the general regulations, a series of specific terms applicable to that operation. If for example a winter geophysical operation was to be conducted in an area which supported a local hunting and trapping economy, the following additional stipulations might be added to the permit.

1. The Company, to guarantee the observance of the operating conditions set out in the permit, will deliver a performance bond, in the amount of $100,000 to the Department in a form satisfactory to the Minister.

2. The Company, will forward the sum of eight hundred and fifty dollars ($850) on the last day of each month in which geophysical operations are carried out. These funds shall be in the form of a certified cheque made payable to the Local Trappers Association trust account and should be forwarded for deposit to the local bank. The Account will be used for the purpose of paying the wages of trappers immediately following their assignment to the exploration crew to monitor the geophysical operation and advise game officers on matters pertaining to the protection of wildlife. The area administrator, will administer these funds and will withdraw from time to time, appropriate sums for disbursement to the trappers involved. A record of account concerning the disbursement of funds for services provided will be maintained and will be forwarded to the company, from time to time, and a final accounting will be made to you following the current phase of operations and any balance of funds will be returned to you;

3. The Company, will provide free transportation, board and lodging to the trappers and game officers assigned to its exploration crews for purposes of monitoring and advising on the conduct of the geophysical operation;

4. The Company, prior to commencement of operations, will obtain the approval of the Regional Director, Canadian Wildlife Service to commence and carry out operations within migratory bird sanctuaries in the permit area;

5. <u>Land Clearing Operations and Stream Crossings</u>

   (a) all bulldozer blades shall be equipped with "mushroom" type shoes which shall at all times be extended a minimum distance of six (6) inches below the cutting edge of the bulldozer blade unless otherwise authorized by the inspector;

   (b) the operator shall so locate crossings of lakes, rivers, streams and gullies so as to avoid where possible excavating approaches, shores, banks, streams and channel beds and, notwithstanding the foregoing, no excavations shall be made by the operator without the prior approval of the inspector;

   (c) debris deposited in any gully, lake, river or stream shall be removed by the operator at a time and in a manner satisfactory to the inspector;

   (d) no scarring the ground surface or removal of surface vegetation, and no cuts or fills shall be made by the operator without the prior approval of the inspector.

6. Wildlife

(a) the operator shall not use machinery or otherwise conduct the geophysical operation so as to harass or unnecessarily disturb wildlife or damage wildlife habitat;

(b) the operator shall agree to abide at all times with the instructions of game officials with respect to any matter pertaining to the protection of wildlife and wildlife habitat.

7. Damage to Works

(a) if the operator causes damage to any property, works, structure or facilities including traps, trapping equipment, during the geophysical operation, he shall

(i) immediately take action to prevent further damage;
(ii) immediately inform the owner, or the inspector or game official of the place and nature of the damage; and
(iii) arrange for the repair of such damage or the replacement of the damaged works as soon as it is possible to do so.

(b) when the operator fails to comply with (a) above, the Director may cause such things to be done as to repair the damage or replace the damaged works and the costs thereof may be recovered from the operator as a debt due to the Crown.

The administration of the land-use program will be carried out in the two Territories under two Regional Water and Land-Use Engineers, one in Whitehorse and one in Yellowknife who in turn will report to the Regional Director of Resources. The field organization will include the present Yukon and Mackenzie Forest Services with a total staff of 60, plus an additional forty land-use inspectors to be hired over the next two years.

The Regional Engineer as chairman of the Territorial Water Board, established under the Northern Inland Waters Act, will also have a staff group to advise him on ecological-biological aspects of applications both for water and land-use permits.

PEOPLE AND THE ENVIRONMENT

R. A. Hemstock
Regional Arctic Co-ordinator, Imperial Oil Ltd.

The traditional ways of travel in the arctic had little impact on the environment, and the people remained relatively isolated. On the other hand, modern transportation and the economic incentive to use it in the arctic will greatly affect the environment and the people that live there.

This paper will consider the impact of transportation under the three main divisions of water, land, and air transportation.

Water Transportation

Water transport was, of course, one of the very earliest methods of moving around in the arctic. It is still the basic method for getting heavy freight into the North--via the Mackenzie River system in the western arctic or by sea in the eastern arctic. By reason of being in order of magnitude lower in cost than other methods (albeit still costly by reason of distance), water transportation has enabled most of the development of the North to proceed to its present level. Water transport will likely continue to be a viable basic transportation method in the foreseeable future. It does not now move people around, nor is it likely to have any effect on people except to provide them with goods from the south.

It has had a minimum effect on the environment, being seasonal, and low volume, and will probably stay in that category except if marine shipping is used to move resources out of the arctic. With that turn of events, there will be enough traffic to be of major concern from an environmental standpoint. Ice strengthened cargo ships and tankers are the most logical and practical means of moving resources out of the arctic islands.

There have been many statements made of the disastrous effects of oil spills in the arctic, but there is too little know to properly evaluate what the effects would be. Certainly biodegradation of oil spills would be slow, and the area is remote and will be difficult to operate in; on the other hand, in ice covered waters, there will be no wave action to disseminate the oil and it should be possible to recover most spilled oil by pumping. In many of the more remote northern waters, ice cover

exists for most of the year and there is very little life to be affected.

Land Transportation

Land transportation includes pipelines, railroads, highways, and cross-country travel.

The earliest northerners were nomadic and moved across the country freely, either by dog teams or simply by hiking. It is only very recently that vehicles have been developed which enable man to move cross country in the north and haul useful loads for development. These vehicles are either tracked or wheeled, and they feature very low ground pressure. They are now capable of hauling up to 30 ton loads. They are slow and costly and have a relatively short range, probably less than 100 miles. These vehicles make it possible to get into remote areas and usually are the mainstay of exploration work. There has been great concern expressed by many ecologists about the widespread ecological damage which will result from their use. However, several studies carried out in the islands, in the Mackenzie Delta, and in Alaska show that with proper care there is very little damage to the terrain. Nevertheless, it may be desirable to limit travel to the winter season in particularly sensitive regions, or where there is wildlife that will be disturbed. Additionally, there is work going on to improve the ground bearing characteristics of vehicles so that surface damage is minimized.

Roads of varying degrees of excellence are being used in the arctic. In heavily traveled areas, some highways are paved and at the other end of the scale is the winter road, used only seasonally and with special vehicles. Most good roads have been built as a result of resource development. The support of northern settlements by road results in better supply and lower cost goods and services. However, it is probable that one of the most important factors is psychological. Remoteness may well be less of a problem if people know that they are connected to the outside world by road and that they can in fact drive by car to other parts of Canada, even though they may seldom do so. A road network, like a communication network, will be a unifying factor for all northerners.

Roads will also result in much adverse effect on the environment. Many ecologists have raised the spectre of disturbed drainage, lost grazing land, thermokarst, etc. These will be by far the least disturbing of the effects. Roads bring people, and people have not yet learned how to live without adverse effect on the environment. People will mean disturbed or hunted wildlife, sewage in the waterways, and garbage on the face of the land.

Railroads are very closely related to resource development because they are high capacity systems. The total mileage of arctic railroads will be small, and the effect on the environment will be negligible. It will also be minor on people except for those whose living costs are reduced by reason of lower costs and year round capabilities of railways.

Pipelines will be used to carry oil and gas from the wellhead to terminals, and from terminals to market. Pipelines are capital intensive single product transportation systems. They will have little people impact. Their eventual effects on the environment are now being studied. Oil lines present the most difficult problems, since the oil carries a great deal of heat, and when the pipe is in contact with icy permafrost, thawing will result. If the lines are built on the surface, then there is the problem of free passage for wildlife and for people across the line. The line could be elevated across depressed areas, so that animals such as migrating caribou could go under. Opinion is divided on whether this much of a barrier would divert the caribou from their normal path, and further study will be required to fully understand the problem. Actual construction of the line will require some of the largest pipeline equipment available, and even with a road paralleling the pipeline, there will be some surface damage. Extensive studies on restoration are going on now, both in Alaska and Canada, and there are encouraging signs that restoration can be effected to stabilize the right-of-way. In any operation where people are involved and where large tonnages of products are handled, there will be accidents. This will apply to marine operations, producing areas, and pipelines. Industry must be prepared to go to great lengths to ensure sound engineering design and mechanical integrity of all installations. Beyond that, however, there must be contingency plans arranged so that accidental spills are contained and then cleaned up. These plans would logically involve some cooperative arrangement between the operators and would have the

approval of government authorities.

Air Transportation

Air transportation is probably the greatest single factor in bringing the twentieth century to the arctic. For the purposes of this paper, we will consider fixed wing aircraft, helicopters, lighter than air vessels, and the hybrids--ground effect machines.

Fixed wing aircraft vary from modern jets to the remarkable new STOL airplanes. They are fast, comfortable, flexible people and high-cost freight movers. Airplanes not only move people quickly, but they seem to shorten the distance to civilization. It should be noted that with newer and larger equipment becoming available, airplanes may eventually challenge other methods as low-cost freighters. The great savings of inventory and minimal handling make them competitive.

Helicopters provide the utmost in flexibility at a higher cost. These vehicles have made possible the wide exploration of the arctic in a minimum time since they provide means for an explorer to see vast stretches of country in good detail in a very short time. This will continue to be the role in the future, and there will not be any great effect on people or on the environment.

From time to time we hear proposals for lighter than air vehicles for arctic freighters. Russia is proposing the use of helium inside a very thin metal skin. There may well be a place for such developments as a mover of freight.

Ground effect machines have so far been held to very specialized work. Present vehicles are short range and somewhat limited in obstacle crossing and slope capabilities. One of the great advantages is the capability of moving over either water or ice or any combination of the two. One would expect ground effect machines to eventually be used along the rivers and coastlines of the arctic. They may be very important in supplying offshore operations. One of the advantages of ground effect machines is that they have little effect on the environment. They will not likely compete with aircraft in moving people.

Summary

It is evident that transportation has a great effect on modern man. He had demonstrated that he desires to live where there are large numbers of his kind. In addition, he has shown a lamentable lack of understanding of the impact of large numbers on his environment. The North is just beginning to attract man's attention, and we are faced with two opposing concepts. "To develop" means to many "to inhabit and use the resources." Many have expressed a desire that Canada encourage people to go north. If this is accomplished and man continues to behave as he has in the south, there may properly be concern about the long-term ecological effects.

On the other hand, the two resource industries that are now in the North are capital intensive, they use relatively few people and are continually striving to use fewer. The oil industry has initiated a system whereby as many local people as possible are hired and the remainder live outside and fly to their work on a rotation basis. The lesser numbers of people will reduce ecological disturbances. The patterns are being set now, and we as Canadians should understand the problem and make sure the correct long-term approach is taken.

As for northern people, they are now a part of the twentieth century; there is no going back. Modern transportation will integrate them even more fully with the south so that whether they appreciate it or not, they will be a part of "the global village."

THE ECONOMIC AND SOCIAL IMPACT OF NORTHERN TRANSPORTATION

BY: A. STEVENSON
Department of Indian Affairs & Northern Development

Before the days of compass and chart, man was involved in transportation problems of our northern regions. Possibly, during the inter-glacial periods, waves of people moved back and forth across the Bering land bridge from Asia. These various groups no doubt dislodged earlier inhabitants of the new world or at times merged with them as they moved east in pursuit of game or from the pressure of tribes behind them.

Archaeologists, historians and accounts of early European explorers give us the picture of primitive people skilled in living in Arctic and sub-Arctic regions, with a well-developed means of transportation. Our knowledge of the Eskimos and northern Indians and their ancestors indicate more than usual adaptability and ingenuity. The Eskimos developed kayaks and umiaks, the skin-covered boats for hunting and travelling. Some Indian groups made moosehide boats and others used birch bark, but in many areas it was spruce bark material, for birch bark in the Territories seldom grew large enough for canoe making. Various types of snowshoes and man-hauled toboggans and sleds were used in his migrations and hunting expeditions. Many centuries ago, primitive hunters began to domesticate the dog to haul sleds and as a pack animal for inland travel in summer; he was man's partner in the hunt and shared the meat of the kill. Although many Indian groups used a breed of dog to bring game to bay, the Eskimos appear to have made greater use of other breeds, all commonly referred to as the huskies, for transportation. Some Indians and Eskimos developed what became well

established trade routes and travelled vast distances to exchange with other tribes food and goods not available in their local regions. This might be raw material such as copper, soapstone, iron and even wood. Naturally, wood was an item of extreme value to remote Eskimos who inhabited the treeless tundra. Some native handicrafts were traded and skins of animals exchanged.

The early European exploration of much of Canada, and particularly of what is now the Northwest Territories and Yukon, was primarily the movement of fur traders pushing farther and farther north and west to tap sources of fur. Fur trading became the oldest economic occupation and dominated all activities in the north for many generations. This industry and its transportation requirements used the skills of northern people. Some Indians harvested the furs; others dominated, in terms of manpower, the transportation network. The lifeline of the fur industry out of the north and west was maintained by Indian and Métis in freight canoes, in York boats and behind dog teams. These men of the 19th and even the 20th century had the strength and skill to man their boats and a knowledge of the country; they took pride in their work. There was a spirit of competitiveness among the voyageurs and coureurs de bois whose physical stamina and spirit made possible the east-west commerce between Montreal and the northwest. The mail runners, competent, speedy and tough travellers either on foot or behind a dog team, performed feats that have become legends of the north.

Gradually the canoes and York boats which had been introduced in 1826, gave way on the Mackenzie River route to barges, pushed by shallow-draft wood-burning stern wheelers. This advance in

transportation technology was again dependent on northern people, many of whom were now located along the river in communities which had sprung up as a result of the fur trade. They played an important role as guides or pilots, passing on to people of the south their information about navigation conditions and hazards. Before the days of diesel fuel, they cut and stockpiled enormous quantities of wood at various depots along the route. For many years this mode of transportation remained generally unchanged on the Mackenzie River system.

In the Yukon the traditional form of transportation was also by water. In the intensive economic activity following the Gold Rush of 1898 the Yukon River became the main thoroughfare; from Whitehorse a narrow gauge railway was completed in 1900 to connect it with the tidewater at Skagway.

At the time, road transportation in both the Yukon and Northwest Territories was of a fairly local nature. Although there had been some transportation by air prior to World War II, it was the world conflict and the rapid development of long-range air travel which broke down the isolation of the north and created vast changes in the transportation and communication picture.

As the outsiders learned the secrets of the north, the services of the northern people were no longer required and the early transportation agencies, like most other Canadians, seemed to forget about the people of the north for many years. Even during World War II when transportation facilities in the north were expanded at a rapid rate, the original people were almost excluded from the construction of roads and air fields.

Canada, for a variety of reasons, rediscovered the north and the people living there in the early fifties. The Canadian Government attempted to make up for the omissions of the past and over a few years introduced improved education, health and welfare services, plus programs related to housing and social development. This period of development was only possible because of the improved transportation systems that had been built up during World War II. For the more isolated areas the aircraft became very important.

Many northern settlements came into being during this period, and settlement life as opposed to the traditional scattered groupings of people became the pattern for northern residents. As this trend towards urbanization increased especially in recent years it has probably been one of the most demanding adjustments and change for the Indian and Eskimo people. More and more families left their small scattered family camps to settle in concentrated communities designed on the model of southern Canadian towns. The trading post has become the general store and the isolated settlements are organized communities in a northern setting. This has led to a more sedentary way of life with all the amenities of a town, such as municipal services, co-operative stores, schools, nursing stations or hospitals, churches, good housing, opportunities for wage employment and other facilities for an active social life within the established town. These settlements with their facilities have become very important for all northern residents. Community councils meet in the community hall or school house. Planes arrive more frequently with the increase in scheduled flights. Films are shown and news from the outside world is received regularly on the small

radios found in most Indian and Eskimo households. The growth of these communities although bringing much that is good has also meant a radical social adjustment for the nomad now turned townsman. Accustomed to the unscheduled and independent life of the camp, some of those employed find it difficult to comply with certain work regulations and the discipline of a nine to five day. The head of the family who continues to hunt and trap may travel on a skidoo instead of by the traditional dog team. He leaves his family in their permanent home and covers his trap line ranging farther afield than in times past. Many of these changes have led to frustration, stress and hostility and the conflicting poles of life styles and values.

As I mentioned, settlement life did introduce some opportunity for full-time employment. Other developments -- exploration - co-operatives -- during the same years created other opportunities. On looking back, it would appear that the men who secured such permanent full-time employment were usually men who had played a leadership role in the more traditional way of life. Unfortunately, these men became involved in a new way of life and quite often their leadership and guidance were lost to their own people at least for a few years.

Settlement life also introduced some seasonal and casual employment as labour was required for the construction of housing, airstrips, schools, nursing stations, power plants and the other facilities required in these isolated units. Such seasonal employment had its ups and downs and really has not been very satisfactory. It gave northern residents spending power for a few months and people were

able to purchase what they felt they needed. Projects like the Frobisher building boom is an example. When the construction came to an abrupt end, the people were left without the funds to satisfy the needs they had acquired. Similarly, other construction projects, such as the DEW Line, created numerous employment opportunities for a limited period, but offered little in the way of continuing employment. Water transportation by river or sea is another area which offers jobs for a limited time of the year. The construction of the proposed pipelines in the Mackenzie Valley will probably be a future example of this kind. The construction will take two to three years; full employment will be available, resulting in good incomes and buying power. But what will the workers do when the construction phase is completed? Will there be a road program which, together with pipelines, will require maintenance people, drivers, mechanics for service stations? If so, then should not training be instigated soon to meet the future needs of pipeline development and related projects?

Until a few years ago, life in most northern settlements was rather isolated from the rest of the Territories and southern Canada. Gradually, and only with the improvement of communications and transportation systems, the people of the north became interested in things outside the confines of their small communities. As transportation improved -- scheduled air flights as opposed to charter flying -- it was possible for the residents of settlements to become involved in life outside their communities. Residents from various settlements were able to get together and discuss problems that were common to all and in which they felt they should

have some involvement. In addition to physical presence, radio and the increased communication by mail, by an exchange of views, has had a great influence on the people.

Before proceeding to this phase of the development of the north, I would like to compare life in the isolated settlements with similar conditions for a particular group of people in southern Canada -- I refer to the under-employed people of urban North America. I have suggested above that the small isolated settlements of the north offer few opportunities for full-time employment and in many cases northern people became involved in casual or seasonal employment and with all the problems inherent in this type of economy. In reality, they were under-employed. In a partial attempt to understand what took place during this particular period for northern people, I would like to refer to studies of the lower income groups and the more insecure occupational groups found in urban Canada. Such studies have indicated that the casual, seasonal or under-employed workers tend to develop a distinct culture, with their own system of ethics, scale of values and motivation as a process of adjustment to the social and economic environment in which they are forced to work and live. This type of sub-culture is sharply at variance on many counts with the more accepted ways of life of the middle-class Canadian. The same studies have noted that education is a vital factor in impressing on middle and upper working class children the values and motivations appropriate to our society and in providing the skills required for economic and social adjustment. <u>It appears to have relatively little impact upon the children of under-employed families</u>.

I am suggesting that at least superficially, life in a large number of northern communities resembles the sub-culture of under-privileged or under-employed urban people in southern Canada. I think it is rather important to recognize what has happened in such northern settlements; it could explain why many northern residents have not reacted like good middle-class citizens. Why should a man be interested in a work situation that offers employment for twelve months of the year when the only concept of employment we have offered him to date has been seasonal or casual employment for three or four months of the year? Why should a northern resident accept employment which he dislikes or is not trained for? At this point I think it should be mentioned that many northern residents have accepted the work patterns exhibited by employees imported from the south. These are often itinerant workers -- here today and gone tomorrow. Many employers accept this type of behaviour on the part of imported southerners but become very upset when the Indian, Eskimo or Métis person disappears from the work site. Perhaps it is time for employers in the north to realize that many northern residents have not attained the status of middle-class Canadian citizens and do not have the same values or motivation as many of us from the south. Hopefully, some understanding will bring about a climate which will improve relations between northern residents and employers from southern Canada. Any improvement will mean that northern residents will be able to participate more fully in and benefit from the economic development of northern Canada.

I am the first to agree that there is much to be done to undo the wrongs of the past. Any attempt to improve conditions at this time

must be geared to the needs of northern people and the same people must be involved in any programs designed to assist them in breaking free of a system of values that we, the southerners, have imposed upon them since the early 1950's. Many projects have been initiated in urban Canada to help under-employed people but the only successful projects to date have been those which allowed the under-employed people to take an active part in coming to grips with their own problems and the conditions under which they live. It is important to help people to help themselves. It is more important to make available to such people the means to change -- free of external intervention and direction which imposes yet another system of values. We have to constantly remind ourselves that people of different backgrounds have different norms or standards. Furthermore, one cannot make chaos of a man's life and expect he will move in serenity and respond with a trusting heart. The challenge of the times, therefore, is how to narrow the gap in order to reach mutual understanding and respect. To do this we must evolve and integrate concepts of the old with the new and relevant social values and reflect these values and attitudes in practical, tangible and meaningful ways. Whether we are dealing with transportation or any other development, it has to be inter-woven with the people.

I realize I have indicated there is much to be done to improve the lot of many northerners. I think you will agree that, without criticizing, this is being realistic and also, past practices are inadequate for the future. Already some northern residents are making it known that they are not happy with existing circumstances and want an opportunity to share in the responsibility of changing

the things that affect their lives. I mentioned previously that the greatly improved transportation and related communication systems have made it possible for people in northern settlements to take an interest in things beyond the confines of their own small community. For example, this Conference, with its large delegation of northern residents, would not have been possible without the greatly improved transportation systems of the last five years. Also, it is doubtful if such northern organizations as the Committee for Original People's Entitlement and the Indian Brotherhood of the Northwest Territories, would have been possible ten years ago. Representatives of these organizations are here today and I am sure that they will make known to us their views. They will be telling us, I expect, that they would like to share with the transportation technologists the making of decisions about the types of transportation and routes that will best meet their needs.

Transportation and related communications in the north have made it possible for social action organizations to come into being. At this particular point in time, it is very important for all of us, including those involved in transportation, to accept the fact that these northern organizations will be making demands on us. Perhaps they will demand more employment for northern people. Perhaps they will demand an opportunity to take part in decision-making about transportation routes and any changes that will affect them. Are the transportation agencies of the north prepared to offer to northern residents more employment opportunities than have been made available in the past? As I have mentioned, there will also

be a need to consult with northern people when transportation planners introduce changes which will have some effect on people living in the north.

We now have young northerners who are fast reaching high school graduation in greater numbers than ever before. Also, greater numbers are completing technical courses. Markoosie - at Resolute Bay - is the first Eastern Arctic Eskimo pilot. He has joined the ranks of a number of Indians and Eskimos in the Mackenzie and Yukon who have entered this exciting field, along with a number of flight engineers and mechanics. These young men are now taking an active part in modern transportation, a part as important as that played by their forefathers in an earlier era, which was also directed toward the development of the north. Many others would like the opportunity to use their education and training in the less traditional pursuits of life. For a great many the old ways - the days of the hunt and trapping - are gone. We wonder what the future will hold! Regardless, with the new mood of today, we must actively adopt now some fresh concepts in the necessary preparation to meet the inevitable changes.

It was only a few years ago that, with the rapid developments and advanced technology, we were often reminded that Indian and Eskimo people are not a modern labour force and lack the educational standards required today. Therefore, on a more optimistic and pragmatic note, let us accept that one of the cornerstones of any framework of a positive social and economic structure is, of course, education. In so far as the Northwest Territories is concerned, in the early 1950's the number of northern children

attending school amounted to about 15% of the school-age population. Today, after a span of nearly 20 years, over 95% of school-age children are attending school regularly. The availability of schools is not, of course, a criterion of the standard of education achieved in them. However, the Federal and Territorial education programs are attempting to provide a system which will give the Indian and Eskimo people equality of educational opportunities with other Canadians. With education comes mobility and with mobility comes choice. This should be the ultimate objective of any policy - to provide a framework within which the northern people may choose for themselves what kind of life they want to live and where they want to live it. For the traditional northerner, there was but one option -- to live off the land; to move where the game was.

Another phase of the educational program is apprentice and vocational training. It is realized that the development of the north requires skilled technical labour. Southern labour has as a rule been difficult to recruit and hold in the remote and harsh environment. It would seem that the most satisfactory solution to the labour requirements is to fill positions by local residents as they are trained for them. In connection with transportation, I have already mentioned the training of young northerners that has been and is taking place with regard to them being helicopter and fixed-wing pilots. Three Eskimo youths are now at the Canadian Forces Base at Borden, Ontario, undergoing two years of flight training involving both fixed-wing aircraft and helicopters. These young pilots represent the new era of the north and reflect what can be done, given the opportunity of education and training. If they can meet

with proficiency the demanding requirements of the flying discipline, then surely they can move into other areas of this technological age.

For manpower potential, last year some 200 Indians and Eskimos who followed the normal academic program reached senior matriculation, while under the vocational training program nearly 1,000 northern residents participated in various trade courses. Young women make up a substantial percentage of these figures and women's role in transportation must also be considered.

In addition to the establishment of settlements and the provision of housing for the families of Indians and Eskimos, and educational programs, the Federal Government has launched several other endeavours aimed at bringing to northern residents some of the benefits associated with a less rigorous way of life. I believe you are all aware of the great stimulus of economic development in the mineral and oil exploration field with the need to find efficient extractive methods of transportation by land, sea or air for these important resources. The north in its long history has never seen such activity. The potential of the Arctic Basin has been placed at 435 billion barrels of oil by the Canadian Petroleum Association -- a total value of more than $1,000 billion -- maybe optimistic speculation, but the possible rewards of any risk-taking are enormous.

Then, associated with all this is the stimulation of opportunities for employment. As part of this latter program the Department of Indian Affairs and Northern Development sponsors a number of activities designed to promote the placement of northern residents, especially Indian, Eskimo and Métis people, in gainful employment

with all sectors of the northern economy. This is carried on in close co-operation with the Government of the Northwest Territories, Government of the Yukon Territory and the Federal Department of Manpower and Immigration. It is only natural that leadership and support should come from government. However, the success of the program is entirely dependent on the extent of the assistance and co-operation provided by employers of manpower whether they be private firms, Crown corporations, or branches of government departments operating in the north.

More specifically, there is a need for the full-scale participation of local managers of these various employers knowing that the policy of their parent organization is to support the objectives of the program through on-site action.

The services and assistance provided by the various governments, such as grants and other aids is designed to encourage participation by employers in order that they can provide the main thrust of the program in northern settlements. Not only do we need to train the northern residents, identify job opportunities, and take placement action, but we also need to offer personalized help until they have proved their capacity for remaining in productive employment.

This calls for special personalized arrangements in recruitment, job orientation and counselling. The screening and interviewing of prospective employees should be geared to the job that must be done and not to unrealistic academic qualifications and extensive work experience. Interviewers should understand something about

the motivation and attitudes of northern residents. Supervisors should also be aware of the need for a different approach than they might adopt with imported employees. Much of this is centered in the supervisors manner of communication and the establishment of work standards that are reasonably attainable by the northern worker. On the other hand, they should not adopt an overly sympathetic attitude which might be taken as permitting less than acceptable work discipline. Coaching sessions may need to be set up in order to provide supervisors with the type of knowledge they need to function with a mixed work force of different backgrounds. We should remove the naive assumption that we need not prepare the work climate for the movement of Indian and Eskimo people into the work force or that all supervising personnel will fully support such a personnel policy. Without the support of on-site managers, such a program is doomed to limited success.

Is there a need for special terms and conditions for employment of native northerners? I have touched on the matter of different norms and standards. Therefore, do native northerners attach the same value to the benefits provided to white southerners when they are offered positions in isolated locations or should there be other types of benefits provided? For instance, with regard to the Public Service, the Isolated Posts Regulations provides an entitlement to special leave to come south and a special allowance for transportation. Medical standards have been established which must be met in order to serve in northern areas. Do we expect the Indians, Eskimos and Métis to meet these standards?

It is my belief, and I am sure this is shared with many others without the aid of a crystal ball, that we are on the threshhold of

another period of tremendous change in the north. The great interest and the advanced technology being applied today in the search for oil and minerals is also leading to great social changes. As a contribution to thinking and discussion about the north of the future including transportation and related developments, may I sum up by offering the following:

(a) The highest priority must be placed on training, education and involvement of northern peoples in transportation and economic development.

(b) In association with (a) there is a need to relate transportation with community development to meet both the physical and sociological problems of the new community structures of the north. The Territorial Government are tackling this with intelligent enthusiasm in their program of Hamlet level government designed to permit people to manage their own affairs and become more and more involved with the decision-making process.

(c) What are the social and human facts of transportation and their importance to those who live in the north; i.e. requirements vis-a-vis socially as against the economic end. In this democratic society does this require that we adopt a new concept of where our primary accountabilities lie - are they really based on a profit and loss sheet or on the needs of people?

(d) Further to item (c), it is not the purpose of this paper to discuss aboriginal rights or whether wildlife preservation, oil and mineral development and other industrial activities including transportation, can all live side by side. Much apprehension is being expressed by many, of possible alarming

damage to land and wildlife resulting from exploration and industrial activities in the frail and sensitive ecological condition of the Arctic and sub-Arctic. These developments, however, will not only have a profound effect on the people of the north but our whole society will be affected. There is no simple panacea when dealing with the most important of resources - human - but it is hoped that the ultimate pattern of resource development will ensure that all values will be wisely considered by the experts and planners in order to yield maximum benefits not only to support many northerners but also to make a substantial contribution to the well-being of Canada and other parts of the world.

Change is inevitable. Northern man in particular is passing through a difficult period of transition. Regrettable as it may be to many, it must be recognized that the traditional way of life, once destroyed, can never be reconstructed. It is hoped, however, from old cultures will arise a vibrant people to harness not only effectively but with wisdom and understanding, the energy and knowledge of humanity. It has been said - "The fuller man's understanding of his place and role in nature, the more efficient will be the resultant culture in enabling him to fill that place and role."

TRANSPORTATION AND ECOLOGY

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I accepted the invitation to speak at this conference with some hesitancy - as evidenced by the fact that my paper was very late in appearing - and with a strong suspicion that the cards would be stacked against any spokesman for the environment. That suspicion finds confirmation in the emphasis disclosed by purusal of the program. Of thirteen sessions, one is divided between people and environment. One can therefore easily deduce that genuine concern for the environment was not one of the major considerations of the organizers. In the circumstances, one must decide whether there is any virtue in bumping one's head against another stone wall. Some of us, however, have been doing that regularly over the past decade and are occasionally rewarded for our efforts by some slight cracking of the mortar or, rarely, by dislodging a few stones. Thus, it is in the hope of making even a small dent in the wall that I appear before you today.

There are further obvious constraints placed upon an ecologist. Clearly the conference has a bias. Development is seen as an unmitigated good. Transportation facilities are essential for development. Therefore increased transportation facilities are also good. Given this philosophy, who in his right mind would let a little environmental damage stand in the way of development? It is crystal clear from observation of

government activities in the north over the past 15 years that this is the dominant philosophy. I would like to enter a plea for the occasional reassessment of such a commitment. The government might, for instance, sponsor a full scale meeting concerned with a specific case study, say Pine Point and the Great Slave Lake railway, with full and free discussion of who benefits and to what extent, who pays and what the effects have been on the environment.

Since other pressures prevented me from getting a paper in on time, I took the opportunity to skim through the collected papers and to read some in detail before preparing these notes. I was struck with the nearly universal callousness of the writers towards the north as a special landscape. The real northerner has a sense of belonging to this great land, and I believe, a love-hate relationship to it. To him, each new development is both a conquest of the north as enemy and an abuse of the north as lover. I make no apology for considering myself primarily a lover of the north who resents the many scars and abuses inflicted on it in the name of progress. In this capacity, I have appointed myself spokesman for esthetics as well as for ecology, although there is other justification for this. By and large, healthy, functioning ecosystems are also esthetically pleasing, whereas those that have been disturbed usually also look like hell.

Ecological Constraints

Ecosystems are complex systems that depend fundamentally on a supply of nutrients, an energy flux and a lot of information for their proper functioning. The nutrients are found in soils and water and are usually cycled and recycled through the system. Losses, as from erosion, are usually made up from such sources as precipitation and the gradual dissolution of parent materials. Energy comes from the sun as radiant energy, is captured by green plants and stored as chemical energy, is extracted

by oxidation in the cells of plants and animals and eventually leaves the system as heat. The information necessary to make the system go is stored in the DNA of the plants, animals and microorganisms that comprise the system.

What features characterize northern ecosystems? First of all, nutrients are scarce. The slate was wiped clean during the Pleistocene and soil forming processes go on extremely slowly. Since the surrounding land is the source of most nutrients in lakes, it is not surprising that most aquatic as well as terrestrial ecosystems are categorized as oligotrophic. Second, energy input is limited, essentially, to the short summer. Third, the fauna and flora are depauperate, that is, there are relatively few species, hence a relatively low information content. The net result of all these is that productivity is low and a corrolary of this is that the recuperative powers of northern ecosystems are also low.

Large areas of the north are also underlain by permafrost which has several biological effects. Of prime importance is the fact that it tends to prevent runoff and precipitation from percolating to any depth and thus keeps moisture in the upper layers where plant roots can reach it. But since the soil above the permafrost is cold, the efficiency of the root cells in using the material is greatly reduced. Permafrost and the associated ground ice also give rise to patterned ground which gives the tundra surface some irregularity and hence creates microhabitats favorable for different kinds of plants and animals. Maintaining the integrity of the permafrost is therefore of utmost importance in maintaining tundra ecosystems.

Another characteristic of northern biology is the intensity and prominence of seasonal phenomena. A considerable variety of birds nest in the far north, although few can cope with the

northern winter. In most, if not all cases, the season is just long enough to encompass mating, laying, incubation and fledging. Any setback ensures that young birds will be unable to make the migratory flights south in time.

Migration is not confined to birds. Terrestrial forms such as caribou, arctic wolf and polar bears, several marine mammals, and many fishes also undertake extensive migrations. Human activities that interfere with these migrations will have severe effects on migrant species.

A further and final feature of northern ecosystems appears to be their cyclicity. Productivity seems to go in waves reaching a crest about once every four years on the average. The best known manifestation of this is the four-year cycle of the lemming but the phenomenon is wide-spread in both old and new worlds. The "unit" of ecological study should therefore be a four-year cycle.

Transportation and Ecology

Water - The greatest effect of water transport is likely to come from losses of hazardous cargo, whether this be along the Mackenzie system or in the Arctic Ocean. Attention is now focused on oil spills, but this is not necessarily the only hazard. It should be borne in mind that anything spilled into the Mackenzie will eventually reach the delta which is a uniquely rich biological area largely because it has an enormous supply of nutrients brought down to it by the river. Clearly there must be an intensification of research into the effects and control of marine pollution. The Arctic Ocean differs in many respects from more southern seas. One biological feature that has received little attention is the fact that most marine invertebrates have a direct life cycle, that is, they have eliminated a free-living larval stage. Since the free-living

larva is the dispersive phase, the implication is that most of these animals pass their entire life in a small area. If a pollution disaster occurred and depopulated an area, resettlement would be extremely slow [(1)].

It seems to me as well that transportation interests should be keeping a close eye on other developments that may have wide-spread ecological effects. The aftermath of the Bennett Dam is now upon us. How will damming of the Liard and southward diversion of the Peace and Athabasca (PRIME) effect cargo carriers on the Mackenzie?

Railroads - If the Great Slave Railroad can be taken as an example, one can conclude that railroads are largely out of sight and therefore do little visual damage. It is to be hoped that rail extensions will not violate areas of special beauty and will not pass close to important biological areas such as nesting concentrations. Attention is required to avoid loss of cargo through spillage, leakage or blowing dust. It is further to be hoped that maintenance of rights of way will not be done with poisionous chemicals.

Aircraft - I am sure that no one here needs to be reminded of the threat that unregulated use of aircraft poses to wildlife. Even when the aircraft is not used to provide access for illegal killing, constant harrying can have severe effects. Large mammals with young at heel are one group that may suffer unduly. A second category is nesting birds. Helicopters, which are usually operated at low altitudes, can cause a great deal of disturbance even when there is no deliberate malice on the part of the operator. Female geese respond to distant helicopters by leaving the nest [(2)]. Frequent interruptions of this nature may lead to death of eggs from cooling or to increased losses from predators.

A further ecological effect of increased air traffic to the arctic arises from construction of landing strips. It is apparent from pictures I have seen that not enough care is originally used in locating strips. The result is that in many cases, strips are duplicated or even triplicated before one is located that is free of thermokarst phenomena. Surely we can, and must do better than this.

Roads- Whatever their other virtues, no one could claim that any northern road is a thing of beauty. Cuts and fills are raw and eroding. River crossings are savaged, including as a prime example, the recent crossing of Trout River near the fall. No attempt is made to avoid desecration of beauty spots accidantally in the path of the road and few detours are made to bring the weary traveller into contact with nearby vistas. Borrow pits and abandoned campsites, complete with garbage and odds and ends of machinery, line the route with no attempt at disguise. Camping sites range from totally inadequate to barely tolerable. Tourists are referred to as "Yo Yo's" - second-class citizens to be victimized rather than treated as guests.

A doctoral dissertation could be written on the human ecology of northern roads, but perhaps I have said enough to indicate that I think there are many ways in which the Northern Roads Program could be improved.

Off-Road Travel - Experience at Prudhoe Bay, Tuk Peninsula, and in the high arctic has shown that unless great care is taken in areas of high ice content permafrost, off-road travel will initiate thermokarst development. Disturbance or destruction of vegetative cover alters the thermal balance and results in degradation of permafrost and surface subsidence. The vegetation of the disturbed area differs from that of the intact tundra and thus probably has a different (perhaps higher) rate of primary production and different palatability for

wildlife. Scars resulting from severe disturbance may quickly attain a depth of several feet and are likely to remain for centuries. In view of this, it is somewhat alarming that Mr. Harwood does not consider permafrost one of the dominant features of the arctic which places design constraints on off-road vehicles.

Having said this, I should add that major petroleum operators have demonstrated that with proper precautions seismic lines can be run at all seasons with little disturbance to surface cover, at least in the vicinity of the Mackenzie delta and Tuk Peninsula.

A great deal more research is needed on the effects of vehicles of different kinds on tundra vegetation and the underlying permafrost. This should include the effect of repeated passage by low ground pressure vehicles and independent tests in the high arctic as well as on mainland tundra.

Pipelines - Major problems of pipelines carrying hot oil in high ice content terrain have been identified by alaskan workers and are generally well known. Engineering constraints under such conditions are severe, and it seems likely that a properly engineered line would satisfy most ecological requirements. It is well recognized that provision must be made for migratory mammals. If the method of choice proves to be burial in a gravel berm, there will be ecological side effects attributable to mining the gravel. In any case, enormous amounts of gravel will be required for the road on which the pipe-laying equipment will operate.

Whether or not caribou will concentrate under an elevated pipeline to benefit from surplus heat can only be determined by

experiment. Similarly, only observation can tell whether caribou so concentrated will be more susceptible to wolf predation.

Once in the boreal forest the ecological effects of pipelines should be no more severe than they are now in northern Alberta. Barring major breaks, the effects are not likely to be severe.
Indirect Effects - As pointed out by Mr. Hemstock, improved transportation is likely to mean more people. People require goods and services and produce wastes which are difficult to dispose of especially under Arctic conditions. More people will also exert more pressure on recreational areas and resources such as fish and game. Because of the low productivity of northern areas, these recreational pressures should be dispersed, but unfortunately the trend seems to be toward concentration in urban areas. Further improvements in transportation, taking account of the needs of people for recreation, could however encourage the desired dispersal.

RECOMMENDATIONS:

It seems likely that ecological and esthetic insults could be minimized by confining surface transportation to corridors as far as possible. Thus, a highway, a pipeline, and if necessary, a railroad, could occupy one such corridor. A likely route for such a corridor would be the Mackenzie valley and I would enter a plea that any surface transportation corridor be carefully planned so as to be undetectable from the river. Thus, at least the illusion of wilderness would be preserved for future travellers to the Arctic by small boat.

It further seems clear that critical areas should be identified immediately and that they should be avoided when transportation networks are planned. By critical areas, I mean

areas of outstanding beauty, of historical or archaeological interest or of scientific importance (IBP ecological reserves).

It also seems to me that the time is past for important decisions effecting the environment to be made _in camera_ with the public being informed only when the bulldozers are on the site. There must be full and free discussion and plans must take account of ecological and environmental effects.

Finally, let me remind you that all resource developments are temporary by nature. Even the fabulous Klondike is now for all practical purposes deserted. Surely our strategy must be to avoid long lasting detrimental effects in the name of short-term expediency. To this end, surface transportation must be planned with great care.

CONCLUSION:

In conclusion, I should like to offer a few words about the objectives of the conference which are:

> "To discuss northern transportation in the 1970's for the purpose of contributing to orderly, social, and economic development, compatible with protection of the environment, through the provision of an efficient, economic, and adequate transportation system."

I submit that development will create environmental problems and that history has amply demonstrated that environmental protection is inconsistent with efficiency and economy. It is my hope, as one who loves the north, that the transportation industry will follow the example set by the petroleum industry in its seismic operations. A high degree of environmental protection has been achieved by that industry at an undoubted cost in efficiency and economy. Only in such acts of good corporate citizenship do I see any hope for orderly development with a

minimum of long-term ecological damage.

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VOLUME 3

SECTION 2 - TRANSPORTATION FACILITY COSTS AND USER CHARGES

CHAIRMAN: J. Welsby

PANELISTS: I. C. Cornblat

E. T. Haefele

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P. Detmould

"Which of you, intending to build a tower, sitteth not down first and counteth the cost, whether he have sufficient to finish it".

The Bible, Luke 14 : 28

TRANSPORTATION FACILITY COSTS AND CHARGES

BY: MR. I.C. CORNBLAT
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INTRODUCTION

Transportation facilities and services in Canada's North have increased extensively in recent years. Air service by jet aircraft, marine voyages by super tankers, a developing highway system in the northwest, are all signs of the growing ingress of modern transportation. As in most things, however, progress requires financing and so it is in the case of the Federal government's involvement in the northern transportation story.

This paper presents an outline of the expenditures and revenues related to the transportation facilities and services provided in the North through the programs of the Federal government. Specifically, financial data relating to air, marine, roads and meteorological activities are presented. The geographical area covered, includes all of the Northwest and Yukon Territories as well as the extreme northern portions of provinces, where Federal transportation services are provided. To assist in localizing some of the data, an arbitrary segmentation of the North into Eastern, Central and Western portions has been performed. Exhibit 1 indicates the boundaries of these

areas.

Because of the high per capita costs in this area, the need for government action in providing facilities is greater than in Southern Canada. Costs of providing transport facilities are high while the revenue base is very small. The introduction of new and sophisticated transportation services has placed an additional burden on existing facilities creating special problems necessitating special and costly solutions. Overcoming the physical problems of the terrain alone is often very costly.

The federal government's involvement in providing transportation facilities in the north has grown considerably in the last five years with capital and operating and maintenance expenditures for 1969/70 fiscal year amounting to over $50M for those services covered by this paper. Considering the growth in expenditures in relation to growth of revenues, Exhibit 2 provides a graphical illustration of the results of fiscal years 1965/66 to 1969/70. It is noted that while for the past two years revenues have been increasing - amounting to almost $11M in 1969/70, the rate of increase (8% per year), is considerably less than that exhibited by expenditures (15% per year).

AIR TRANSPORTATION

Federal government responsibilities for providing services and facilities for private and commercial air transportation in the north, are primarily vested in the programs of the Canadian Air Transportation Administration of the Ministry of Transport. The following text and data therefore, with the exception of the section relating to the Resource Airport Program (administered by Department of Indian Affairs and Northern Development), detail the activities of the Ministry in this region, for the period 1965/66 to 1969/70.

The provisioning of air services and facilities can be grouped into two general activity classifications:

(1) Airports and Associated Ground Services; and

(2) Air Navigational Services.

The pertinent financial data on expenditures and revenues have been arranged to recognize this activity grouping and as well to provide a breakdown by stations and geographical areas. Exhibit 3 summarizes expenditures and revenues for the last five years, while Exhibits 4, 5 and 6 provide detailed figures by site for each of the Eastern, Central and Western Areas, respectively.

Airports and Associated Ground Services

This activity provides for the construction, operation and maintenance of civil airports. It includes provision of emergency services and maintenance and repairs to buildings for the Air Navigational Services activity and the Meteorological Administration where these buildings are located at airports. At many Arctic locations this involves the supplying of light, heat and power to others located at or near the airport sites on a recoverable basis.

Air Navigational Services

This activity covers the designation of channels for the passage of aircraft, the determination of their associated facilities, the development of related standards, the inspection of air space involved, the operation of aircraft used primarily for the calibration of navigation aids and inspection of runways and manoeuvering areas; the design, construction, installation, operation and maintenance of telecommunications and electronic facilities and the provisioning of an air traffic control system.

Capital Expenditures

Airport Activity. The federal investment, as of March 31, 1970, in northern airports and related ground facilities, exceeded $76M, concentrated at 19 airports and 33 air navigation (aeradio) sites (14 of which are located at airports). Exhibit 7

gives a breakdown of these figures for some of the larger sites.

In the past five years $10.5M has been allocated for airport capital expenditures. These investments include air terminal buildings, runways and related facilities (e.g. lighting), with minor amounts being provided for the replacement of vehicles, installation of sewer and water facilities, power plants and heating equipment.

Air Navigation Activity. Capital expenditures in this activity are primarily for the procurement and installation of electronic communication and navigational aid equipment. The Ministry maintains an extensive communication system in the North for, inter alia, the passage of flight information, meteorological data and general safety purposes. The expansion and modernizing of this system is a continuing program. On the navigational aids aspect, the majority of capital expenditure relates to extending and improving enroute services through V.O.R. and radio beacon installations and to improving landing services with the installation of Instrument Landing Systems. In addition to the foregoing there is also the normal program of vehicle replacement and construction of buildings to house personnel and the electronic equipment.

Total capital investment in Air Navigational facilities up to March 31, 1970, is recorded at $16.6M (See Exhibit 7),

with approximately $4M being expended in the past five years. Additionally, over $1M have been invested in providing communication and navigational aid services in support of Marine operations in the North.

Continuing Requirement for Capital Investment. The continuing need for additional capital investment in air transportation facilities in the North can be attributed to three main factors:

1. The economic expansion in general and the opening of specific remote areas for natural resource development in particular.
2. The continuing improvement in safety and reliability of facilities and services enabled by new advances in the fields of aero-dynamics and electronics.
3. The normal replacement costs associated with maintaining some $93M of assets in continual use, in some of the severest weather in the world.

Operating and Maintenance Expenditures

As might be expected, it costs more to operate air transportation facilities in the North than it does in the more southerly portions of Canada. Items such as heating, food, isolation allowances, power, transportation and weather severity all combine to increase O&M costs. As indicated in Exhibit 3, operating and maintenance expenditures have experienced a growth

rate of 6% to 7% per year since 1965/66 and now exceed $4.8M for the airports activity and $4.4M for air navigational services. It is anticipated that these expenditures will maintain, or more probably exceed, this growth rate for the next few years.

Assuming a percentage of 50% for the portion of total O&M costs accounted for by salaries, it is noted that approximately $4.5M was paid out in 1969/70 to the staff of the Canadian Air Transportation Administration stationed in the North.

Revenue

Revenues for airports and air navigational activities are derived from a few basic sources. The following gives a listing of the revenue sources for each activity and indicates their percentage contribution as based on revenue collected in the period 1965/66 to 1969/70.

		Revenue ($000's)	Percentage
Airports -	Rentals	1,532	31.5%
	Concessions	411	8.5%
	Permits & Licenses	127	2.6%
	Sales (mainly utilities)	897	18.5%
	Service Fees	1,852	38.5%
	Miscellaneous	18	0.4%
		4,837*	100.0%
Air Navigation -			
	Rentals	418	43.3%
	Message Tolls & Service Fees	397	41.2%
	Sales	136	14.0%
	Miscellaneous	15	1.5%
		966*	100.0%

* Total excludes Churchill operation.

Makeup of Various Categories of Revenue

1. Rentals. Rentals consist of the following types:

- employee living quarters.
- hangar storage rentals.
- land rentals.
- tanks and pipelines.
- office and shop.
- equipment rentals.
- transmission line privileges.

Rentals can vary considerably from year to year by site depending upon the level of activity in the area.

2. Concessions. The bulk of this revenue results from the handling of aviation fuel and oil at airports. For example, over a five-year period in Western area sites covered by this report, $274,000 of a total of $295,000 for concessions came from this source.

3. Permits and Licenses. The sale of permits and licenses accounts for a very small portion of total revenues collected at airports.

4. Sales. The bulk of sales revenue comes from supplying light, heat, and power to others located adjacent to airports or in some cases Aeradio stations.

5. Service Fees. Approximately 50% of service fees at airports are from aircraft landing fees with the balance being made up of various recoverable services and receipts from Air Administration Messes.

6. Message Tolls and Service Fees - Air Navigation Activity. Upwards of 90% of the revenue in this area covers user charges for Air-to-Ground Aeradio messages with the balance being for miscellaneous services.

Future Revenue

As indicated in Exhibit 3, airport revenues have annually amounted to approximately 20% of operating expenditures (with exception of 1969/70 where revenue equalled 38% of O&M costs). In the air navigation activity, the percentage has been approximately 5%. Recent changes in policies of the Ministry of Transport concerning user-pay concepts and increasing air activity in the North, may result in increased revenues as a percentage of costs.

Resource Airport Program

This program provides for federal financial assistance to resource development companies for the construction of landing strips and airports. The following table (No. 1) presents a breakdown of expenditures in this program for the past five years.

Table 1

Resource Airport Program - Expenditures

Fiscal Year	N.W.T.	Yukon	Total
1965/66	8,200	-	8,200
1966/67	-	-	-
1967/68	-	-	-
1968/69	-	9,333	9,333
1969/70	90,475	9,525	100,000
TOTAL	98,675	18,858	117,533

For purposes of this program, resource airports are divided into two categories: Exploratory airports and Preproduction airports. Exploratory airports are built during the initial exploratory work of the exploration program. Federal assistance is provided to defray 50% of the cost of such landing facilities up to a maximum federal expenditure of $20,000 per site.

Preproduction airports are built to assist in the preproduction or early production phases of resource development and are constructed to a higher standard than exploratory airports. Federal government assistance is available to defray 50% of the cost of a preproduction airport up to a maximum federal government expenditure of $100,000 per airport. Private, tourist or recreational enterprises are also eligible for assistance under the resource airport program.

This program is administered by the Department of Indian

Affairs and Northern Development which does not realize any "user charges" under the program.

MARINE TRANSPORTATION

The Canadian Marine Transportation Administration of the Ministry of Transport, is responsible for the majority of Federal government involvement in marine activities in the North. Consisting primarily of Arctic Supply with ice-breaking, the administration of the Port of Churchill - a National Harbour and the provisioning of marine communication and navigational aids, these activities are operative only from approximately June to October of each year.

ARCTIC SUPPLY

The Arctic Supply activity involves the annual sea lift of bulk supplies to posts, settlements and installations located in the Arctic, mainly in the Eastern Arctic but extending as far West as Resolute Bay.

At the present time, the major portion of the bulk

supplies required in the Arctic is carried in Ministry of Transport vessels (i.e. Canadian Coast Guard vessels) or in vessels chartered for this purpose by the Ministry of Transport.

The annual sea lift, most of which originates in the Port of Montreal, normally commences about the end of June and continues until mid-October. Numerous coastal settlements and missions are served by the Marine sea lift as well as posts and installations of other government departments including the Joint Arctic Weather Stations, and, under agreement with the United States Air Force, and the Dew Line sites. The principal ports-of-call include Frobisher Bay, Pangnirtung, Clyde River and Pond Inlet on Baffin Island; Igloolik and Hall Beach in Foxe Basin; Rankin Inlet, Chesterfield Inlet and Baker Lake on the northwest coast of Hudson Bay and Resolute Bay on Cornwallis Island.

During the 1969 sea lift a total of some 85,000 tons of general cargo and bulk oil were delivered to all northern points. The general cargo includes such items as prefabricated building material and house trailers. The Canadian Coast Guard vessels also supply the necessary icebreaking support and, in some areas, seagoing living accommodation for the stevedoring and landing barge crews which must accompany the supply vessels.

In the course of the northern supply activity, a

considerable amount of scientific and hydrographic work is also done by the Canadian Coast Guard vessels. In recent years an appreciable amount of effort has gone into probes relating to possibly extending the shipping season and to the problems of access to potential mineral developments.

The Marine Transportation Administration has little or no direct capital investment in northern facilities provided explicitly for the supply activity. The Canadian Coast Guard vessels used in the supply operation see service elsewhere during the off-season and because of this, their costs cannot be wholly attributed to northern marine activity. It should be noted though that increased capital expenditures have resulted from the fact that many of these vessels are designed and built to the rigid specifications demanded by northern marine conditions.

The annual operating cost of this activity for 1969/70 reached $8.9M while the cost for the five-year period under review was $39.3M (see Table 2). This figure includes those annual costs which can be directly attributed to the supply runs (i.e. the cost of chartered vessels, the contracts for stevedoring and port agent's services and the cost of the administration of this activity) which for the most part, are recovered through charges to cargo consignees. Also included is some $4.6M for 1969/70 representing Coast Guard vessel

operating costs for the time engaged in the Arctic and for which no charge is presently levied on either cargo consignees or on other beneficiaries of the voyages.

Table 2.

MARINE ARCTIC SUPPLY PROGRAM
ANNUAL OPERATING COSTS & REVENUES

($000's)

	DIRECT COST	COAST GUARD SHIPS	TOTAL COST	COLLECTED REVENUE
1969/70	$4,264	$4,628	$8,892	$3,559
1968/69	4,227	4,186	8,413	2,683
1967/68	3,593	3,766	7,359	3,890
1966/67	3,495	4,150	7,645	2,111
1965/66	3,412	3,580	6,992	2,362

Port of Churchill

As part of the federal involvement in the North, the port of Churchill represents a capital investment (cost) at December 31, 1969 of $18.7M. Although this harbour is situated at the entrance of the Churchill River on the west side of Hudson Bay in the Province of Manitoba, it comes under federal jurisdiction as a National Harbour.

Wheat is the major commodity handled at this port although fuel oil and bulk petroleum have experienced gains.

During 1969, 86 vessels of a total net registered tonnage of 282,577 tons arrived at the port and overall cargo handled totalled 720,044 tons.

Table 3 summarizes capital expenditures and operating income at the port for the period 1965 to 1969.

Table 3.

PORT OF CHURCHILL EXPENDITURES AND REVENUES
($000's)

	OPERATING AND ADMIN. COSTS	CAPITAL EXP.	REVENUE
1969/70	$2,348	$ 396	$2,255
1968/69	1,582	1,166	1,678
1967/68	1,541	560	1,490
1966/67	1,371	447	1,257
1965/66	1,301	160	1,384

Marine Communications and Navigational Aids

As marine communication and navigational aid services are only required for a portion of the year, the required facilities are provided and operated primarily by the Canadian Air Transportation Administration which operates somewhat similar facilities for northern air transportation, on a continual basis. Examples of combined Marine/Aeradio communication stations are Frobisher Bay, Fort Chimo, Chesterfield Inlet, Poste de la Baleine, and Churchill. The most important exception to this

situation occurs at Hay River where the Marine Administration operates a Marine Agency to serve the surrounding waterways.

As mentioned in the Air Transportation section of the paper, the cost of providing the related marine communication and navigational aid services, has amounted to approximately $1M to date. The expenditures at Hay River have amounted to approximately $500,000 up to the present.

NORTHERN ROADS

Expenditures on northern roads continue to increase as communities grow and the necessary links between these are constructed. The Department of Indian Affairs and Northern Development is the principal agency within the Federal government responsible for roads under its Northern Roads Program. During the period 1965/66 to 1969/70 a total of $35.1M in capital expenditures was spent for construction of roads while the operation and maintenance costs totalled $8.6M. Exhibit 8 gives a breakdown of these expenditures for the Northwest Territories and Yukon. Operating and maintenance costs are 85% covered by the Federal government while the Territorial Governments provide

15% of the costs of upkeep.

Roads constructed under the northern roads program are divided into two main categories; 1) communications and network roads and 2) lateral roads. Capital expenditures by category are presented in Exhibit 10. The first category accounted for \$32.9M of expenditures in the past five years and include highways and secondary trunk roads connecting the territories with each other and the provinces and connecting main centres within each territory. These roads are constructed entirely from funds provided by the Federal government. However roads within communities and tourist sites are the responsibility of the territorial governments.

Lateral roads are broken down into sub-categories which include: Area Development Roads; Resource Development Roads; Permanent Access Roads; Initial Access Roads and Tote Trails. Each type of road in this category receives varying amounts of Federal government assistance ranging from 50% to 100%. In the period from 1965/66 to 1969/70, the Federal government contributed \$2.2M towards these programs. Industries involved in the development and extraction of minerals, oil and gas, sawmills, tourist lodges, or any industry which will add to the growth and development of the territories may be eligible for federal road building assistance under the Northern Roads Program.

The Area and Resource development roads are financed completely by the Federal government. The cost-sharing terms for the other types of roads in the "Lateral Roads" category are outlined below.

1. Permanent Access Road: The Department of Indian Affairs and Northern Development may authorize a federal contribution of up to two thirds of the cost of construction of the road but not exceeding 15% of actual capital invested by the company prior to commencement of commercial production or exploitation, or $40,000 per mile, whichever is the lesser.

2. Initial Access Road: The federal government assistance for this type of road will not exceed 50% of the company's expenditure on exploration or development of the project. The maximum yearly contribution is limited to $100,000 if the project is exploratory in nature and $500,000 if the project is in its development stage.

3. Tote Trails: Tote trail contributions are financed and administered by the applicable territorial government. Financial assistance may amount up to 50% of the cost of construction, but shall not exceed $20,000.

Revenues Derived From Use of Roads:

Revenues accruing to the territorial governments for the use of roads in the past five years amount to $9.5M. These are

derived from fuel taxes and motor vehicle licenses and are presented in Exhibit 9. It should be noted that revenues derived from the use of roads in the North are placed in the central treasury fund and are not limited to use on highways but are available for other programs.

METEOROLOGICAL SERVICES

Meteorological stations in the North are mostly involved in making observations for purposes of weather analysis both on a national and a regional scale. A few of the offices have facilities and staff for local interpretation and presentation of weather information to local users.

Operation and Maintenance

With regard to operation and maintenance costs, these represent the out of pocket costs to Meteorological Services for annual operating expenditures and include salaries, wages and other costs for supplies and some maintenance. Over the past five years these costs have amounted to $11.7M but do not include

maintenance to equipment and buildings provided free to Meteorological Services by other activities within the Ministry under long standing agreements.

A particular case in point is in regard to the costs of operating the Arctic Weather Stations at Alert, Eureka, Isachsen, Mould and Resolute. The operating and maintenance costs shown in Exhibit 11 include all costs for air transport but do not include costs of marine supply now borne by the Marine Administration of the Ministry of Transport.

Another case of a different nature is the fact that the operating and maintenance costs shown do not reflect any Administration loading or any apportionment of the costs of operating long line teletype and similar facilities for the gathering of data and dissemination of weather information. These costs are presently borne by Meteorological headquarters on a national basis.

Capital Expenditures

Capital costs shown in Exhibit 11 are a record of actual capital outlays in each of the fiscal years indicated. For the total period under review, these amounted to $2.6M for meteorological equipment and related operational facilities such as houses, warehouses, garages, etc.

Revenue

The revenues referred to in Exhibit 11 are almost

exclusively those received from employees in payment for lodging provided by the Ministry. Small amounts of revenues are reported as fees representing charges to agencies outside the government for the transmission and receipt of messages relating to their business operations. There are, however, no user charges being levied at present to any agency, transportation or otherwise, in the Arctic for Weather Services.

Additional revenues of approximately $17,000 were realized at Alert, Eureka, Isachsen, Mould Bay and Resolute in the fiscal year 1969/70 but are not reported in Exhibit 11(b) because of being credited back to the responsibility centre budgets of the location. These revenues were obtained from meal charges to personnel of various government and outside agencies; rental of equipment to various government departments and other agencies; reimbursement of airlift costs from Resolute to Mould on behalf of a private firm under contract to U.S.A.F. and the sales of aviation fuel to outside agencies.

The purpose of the Aerial Ice Reconnaissance and Ice Advising Service is to facilitate and minimize danger to the movement of ships in the ice infested navigable waters of the Arctic and Hudson Bay. The service protects ships in currently designated shipping lanes and will assist in the development of new routes (e.g. the route followed by the Manhattan).

The costs shown are out of pocket costs to Meteorological Services for Aerial Ice Reconnaissance only and do not include the costs of support received from elsewhere within the Ministry (e.g. communication costs and the meals and accommodation subsidization of ice reconnaissance personnel at bases such as Resolute). Ice forecasting and Advising Services are provided by the Ice Forecast Central, Halifax, N.S. A portion of its operational costs would also have to be added to those shown above to get more realistic cost figures. This has not been done. At present these services are provided free to all shipping agencies requesting ice information.

SUMMARY

Growth is the theme in each of the air, marine, roads and meteorological sections of this paper as annual expenditures and revenues have increased considerably over the five year period studied. Exhibit 12 summarizes the expenditures and revenue data for each of the sections for this period. It is noted that annual Federal expenditures have increased from \$31M in 1965/66 to over \$50M in 1969/70 with the largest increase coming in the road activity which has climbed from \$11M per year to \$21M in 1969/70. As well, road related expenditures have been growing the fastest at 17% per year.

In the air activity, annual expenditures more than doubled to $13.7M from 1967/68 to 1969/70, considerably outpacing each of the other areas in this time period. As well, the revenues collected for air services and facility usage rose by 90% to over $2M in this period.

As indicated graphically in Exhibit 1(a) total Federal expenditure on Transportation facilities in Northern Canada have exceeded, by a considerable margin, the total collected revenues. The past two years in particular, have shown a widening of the gap between expenditures and revenues and if the present trend continues net annual Federal expenditures in the North will continue to rise.

EXHIBIT 1

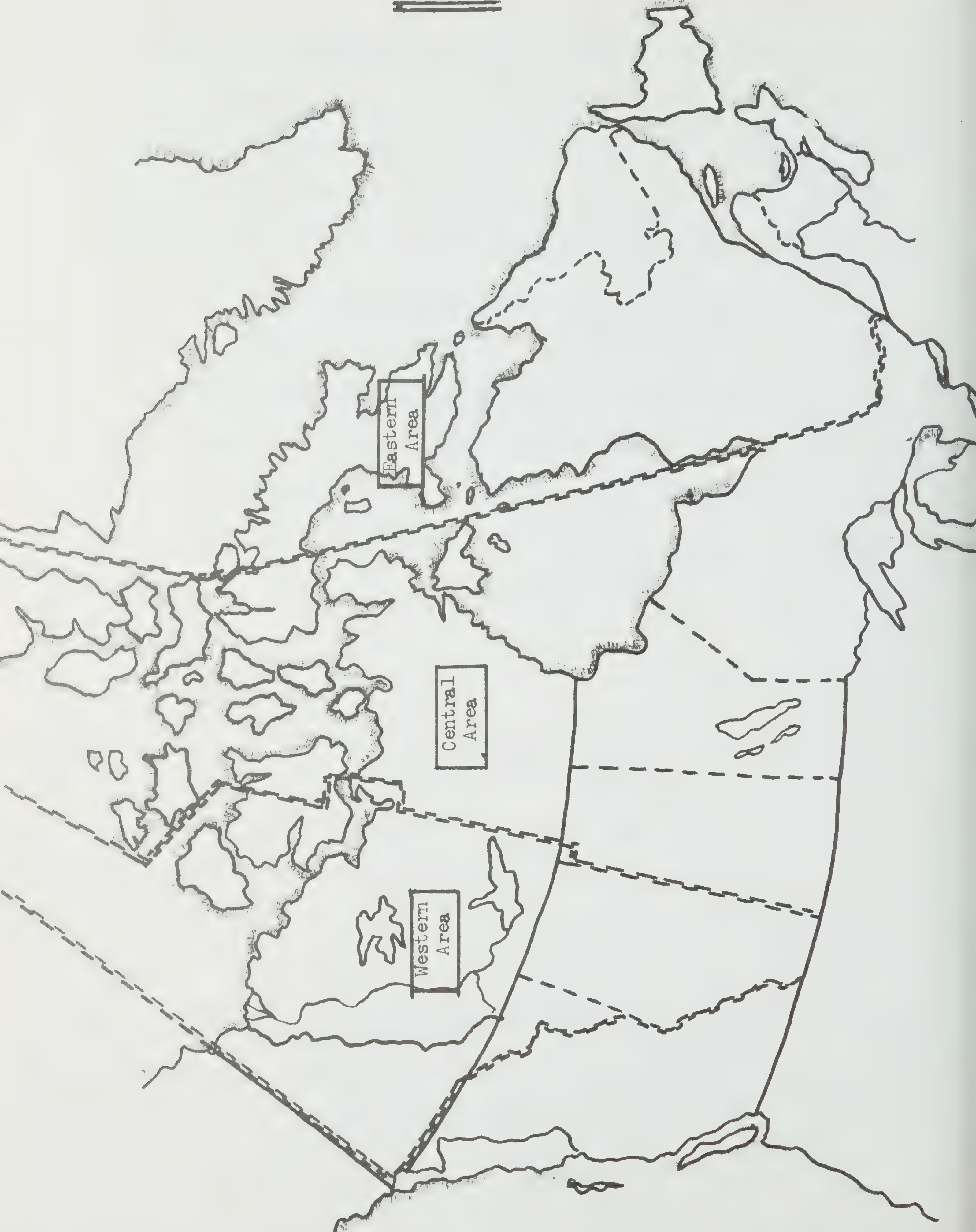
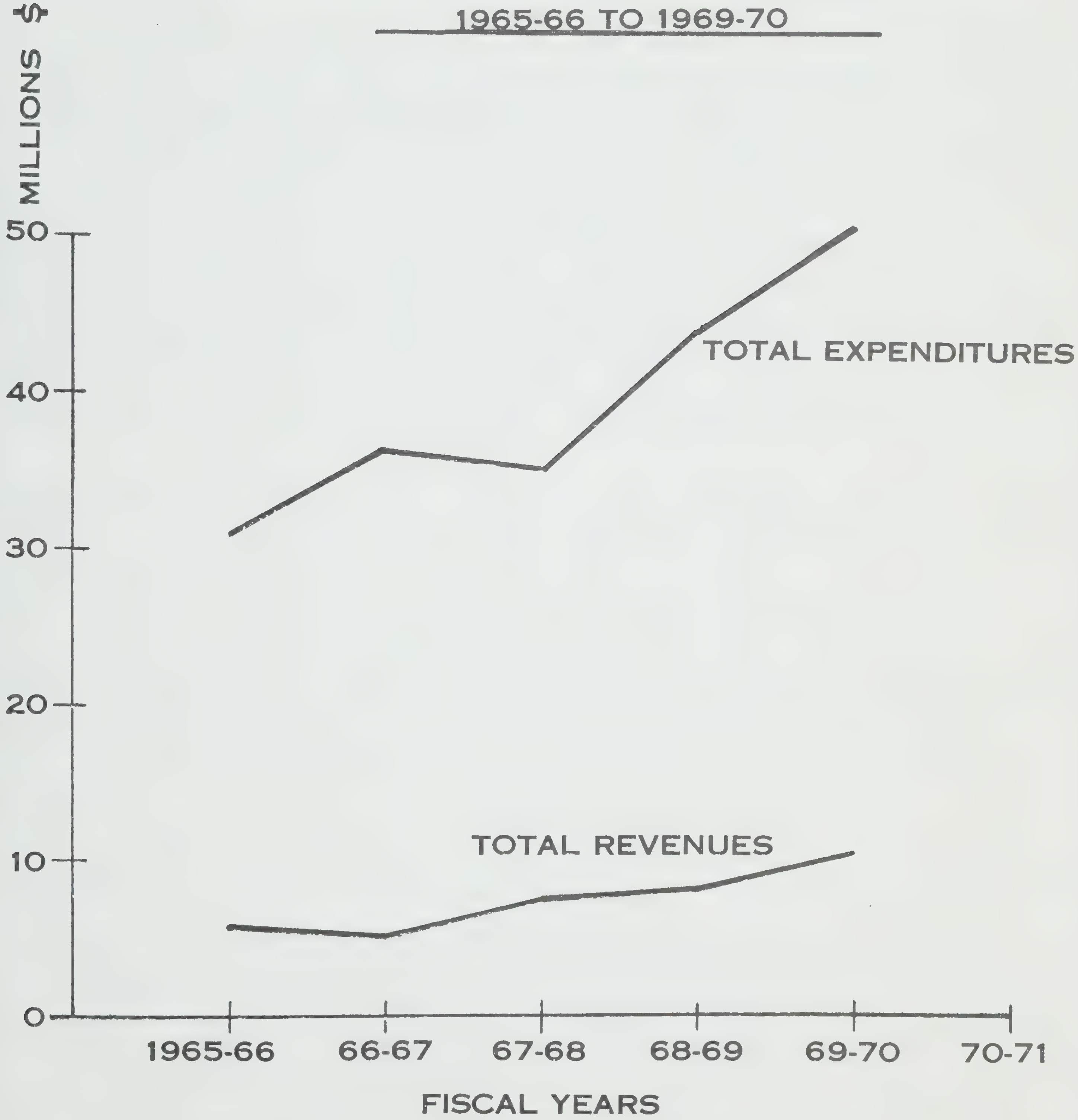


EXHIBIT 2

FEDERAL GOVERNMENT EXPENDITURES & REVENUES AS RELATED TO TRANSPORTATION IN THE NORTH 1965-66 TO 1969-70



(REFERENCE EXHIBIT 12)

EXHIBIT 3

Summary of Expenditures & Revenues
at Northern Sites.
Canadian Air Transportation Administration

AIRPORT ACTIVITY ($ 000's)

AREA	1965/66 O&M.	CAP.	REV.	1966/67 O&M.	CAP.	REV.	1967/68 O&M.	CAP.	REV.	1968/69 O&M.	CAP.	REV.	1969/70 O&M.	CAP.	REV.
EASTERN	588	54	108	619	8	105	852	35	155	853	933	106	894	881	114
CENTRAL	1539	158	444	1592	304	329	1832	84	216	1900	344	276	2246	292	1135
WESTERN	1676	853	329	1668	669	357	1557	1369	316	1797	1834	426	1662	2714	572
TOTALS	3803	1065	881	3879	981	791	4241	1488	687	4550	3111	808	4802	3887	1821
AIR NAVIGATION ACTIVITY															
EASTERN	649	117	19	723	46	16	781	46	52	714	102	77	898	56	60
CENTRAL	1250	230	53	1052	231	19	1083	98	35	978	245	71	1516	138	79
WESTERN	1541	477	125	1450	868	113	1391	363	122	1634	478	99	2026	421	131
TOTALS	3440	824	197	3225	1145	148	3255	507	209	3326	825	247	4440	615	270

EXHIBIT 4

Expenditure & Revenue Data:

EASTERN AREA - Canadian Air Transportation Administration

AIRPORTS ACTIVITY ($ 000's)

SITE	1965/66			1966/67			1967/68			1968/69			1969/70		
	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.
Fort Chimo	189	7	16	205	5	19	254	-	15	276	880	17	273	881	24
Frobisher	399	47	92	414	3	86	598	35	140	577	53	89	621	-	90
Inoucdjouac	- - - - - - - - - - - - - construction in progress - - - - - - - - - - - - -														
Poste de la Baleine	- - - - - - - - - - - operated by Province of Quebec - - - - - - - - - - -														
TOTALS	588	54	108	619	8	105	852	35	155	853	933	106	894	881	114

AIR NAVIGATION ACTIVITY

SITE	1965/66			1966/67			1967/68			1968/69			1969/70		
	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.
Cape Hopes Advance	61	1	-	67	2	1	70	-	1	60	1	1	63	-	1
Deception Bay	-	7	-	-	4	-	-	-	-	-	-	-	-	-	-
Fort Chimo	69	26	3	68	17	3	66	15	4	67	13	7	93	-	9
Frobisher	383	33	16	290	10	7	378	14	40	363	23	62	503	42	40
Inoucdjouac	-	-	-	83	4	2	80	17	3	40	43	2	50	-	3
Nottingham Is.	96	42	-	114	-	1	76	-	1	67	13	1	54	-	1
Poste de la Baleine	-	2	-	68	5	2	64	-	3	76	9	4	83	14	6
Resolution Is.	40	6	-	33	4	-	47	-	-	41	-	-	52	-	-
TOTALS	649	117	19	723	46	16	781	46	52	714	102	77	898	56	60

EXHIBIT 5

Expenditures & Revenue Data.

CENTRAL AREA - Canadian Air Transportation Administration

AIRPORTS ACTIVITY ($ 000's)

SITE	1965/66			1966/67			1967/68			1968/69			1969/70		
	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.
Baker Lake	138	121	2	237	97	15	165	34	43	180	39	48	114	9	98
Churchill	192	13	25	213	51	18	356	4	33	538	48	36	303	49	48
Coral HBR.	211	12	5	210	58	8	147	12	6	169	109	7	349	11	81
Resolute Bay	998	12	412	932	98	288	1164	34	134	1013	148	185	1480	223	908
TOTALS	1539	158	444	1592	304	329	1832	84	216	1900	344	276	2246	292	1135
AIR NAVIGATION ACTIVITY															
Alert	-	6	-	-	-	-	-	-	-	-	9	-	-	18	-
Baker Lake	128	25	13	59	25	-	56	8	-	50	29	-	157	6	1
Chesterfield Inl.	90	15	3	96	34	4	79	1	5	93	-	-	92	6	-
Churchill	312	48	26	288	97	10	305	58	9	295	36	41	367	7	13
Coral Hbr.	113	13	3	98	11	4	73	16	2	61	24	2	91	4	1
Ennadai Lk.	96	-	-	100	-	-	88	-	2	64	-	-	111	-	-
Eureka	-	-	-	-	-	-	-	-	-	-	15	-	-	10	-
Gjoa Haven	-	-	-	-	-	-	-	2	-	-	8	-	-	-	-
Isachsen	-	-	-	-	-	-	-	-	-	-	6	-	-	35	-
Mould Bay	-	4	-	-	-	-	-	-	-	-	8	-	-	16	-
Repuke Bay	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-
Pelly Bay	-	-	-	-	-	-	-	4	-	-	9	-	-	-	-
Resolute Bay	511	73	8	411	63	1	482	9	17	415	73	28	698	6	64
Spence Bay	-	-	-	-	-	-	-	-	-	-	5	-	-	16	-
Arctic Bay	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-
Grise Fiord	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-
Pond Inlet	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-
Igloolik	-	-	-	-	-	-	-	-	-	-	3	-	-	14	-
Misc. (under $10 M)	-	5	-	-	1	-	-	-	-	-	9	-	-	-	-
TOTALS	1250	230	53	1052	231	19	1083	98	35	978	245	71	1516	138	79

EXHIBIT 6a

Expenditures & Revenue Data.

WESTERN AREA - Canadian Air Transportation Administration

AIRPORT ACTIVITY ($ 000's)

SITE	1965/66 O&M.	CAP.	REV.	1966/67 O&M.	CAP.	REV.	1967/68 O&M.	CAP.	REV.	1968/69 O&M.	CAP.	REV.	1969/70 O&M.	CAP.	REV.
Aishihik	72	-	2	36	-	1	closed	-	-	-	-	-	-	-	-
Burwash Ldg.	-	3	-	-	6	-	-	-	-	-	-	-	-	-	-
Cambridge Bay	379	133	81	380	16	115	334	-	61	352	51	77	330	17	59
Dawson	6	-	-	Operated by Yukon Gov't. & Fed. Dept. - I.A.N.D.											
Ft. Resolution	81	53	10	69	-	4	71	2	4	81	42	4	68	19	4
Ft. Simpson	59	38	8	67	46	7	67	5	9	90	64	10	68	31	12
Ft. Smith	116	16	39	132	20	30	139	5	26	171	208	28	158	17	33
Hay River	70	3	13	62	97	14	64	1237	16	76	912	27	103	572	40
Inuvik	75	18	17	92	3	16	96	-	19	112	323	25	98	802	44
Mayo	4	-	-	Operated by Yukon Gov't.											
Norman Wells	133	268	27	152	17	34	181	44	33	192	16	47	195	833	64
Sachs Hbr	-	18	-	-	-	-	-	-	-	-	-		-	-	
Snag	53	-	2	24	-	1	closed			-	-	-	-	-	-
Teslin	41	7	1	Operated by Fed. Dept. of Public Works											
Watson Lk	231	15	28	239	20	29	248	35	30	276	113	32	250	379	39
Whitehorse	213	153	50	275	176	44	209	13	55	255	27	89	225	11	114
Wrigley	60	49	7	46	27	10	46	-	6	64	40	4	38	18	5
Yellowknife	83	79	44	94	241	52	102	28	57	128	38	83	129	15	158
TOTALS	1676	853	329	1668	669	357	1557	1369	316	1797	1834	426	1662	2714	572

EXHIBIT 6b

Expenditure & Revenue Data.

WESTERN AREA - Canadian Air Transportation Administration

AIR NAVIGATION ACTIVITY ($ 000's)

SITE	1965/66			1966/67			1967/68			1968/69			1969/70		
	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.
Ashihik	42	-	2	25	-	1	closed								
Burwash Ldg.	-	106	-	33	461	-	78	6	6	84	2	4	85	-	5
Cambridge Bay	122	1	8	100	-	4	118	-	8	132	5	9	195	35	20
Contwoyto	-	-	-	65	-	-	65	-	-	71	5	-	71	-	-
Coppermine	114	151	30	90	22	31	123	95	26	125	3	3	154	-	4
Dawson	77	15	7	79	-	5	66	-	7	76	-	6	74	-	6
Ft. Good Hope	62	94	2	61	166	17	50	-	23	44	23	19	65	3	15
Ft. Reliance	5	-	1	7	-	-	-	-	-	-	-	-	-	8	-
Ft. Resolution	60	15	6	53	56	4	50	8	5	59	28	5	70	12	7
Ft. Simpson	78	1	4	79	4	4	63	-	3	67	6	3	75	-	3
Ft. Smith	187	4	12	119	8	5	105	-	7	156	6	8	207	4	14
Hay River	68	4	-	67	8	-	69	2	1	88	14	-	102	183	1
Inuvik	108	5	8	102	2	6	106	84	2	134	17	1	151	77	2
Mayo	58	19	6	62	40	5	41	2	4	46	114	3	52	-	5
Norman Wells	136	9	15	109	37	10	72	57	6	81	19	5	91	-	6
Sachs Hbr	-	10	-	-	4	-	-	-	-	-	-	-	3	-	-
Snag	43	-	2	23	-	1	closed								
Teslin	52	-	5	63	48	3	54	4	3	60	2	4	65	-	6
Watson Lk	66	23	5	48	-	4	51	22	7	54	8	8	76	70	12
Whitehorse	157	12	8	158	8	9	145	11	11	194	21	14	290	6	10
Wrigley	14	-	2	14	-	2	15	-	2	14	-	2	19	-	4
Yellowknife	92	8	2	93	4	2	120	72	1	149	205	4	181	23	11
TOTALS	1541	477	125	1450	868	113	1391	363	122	1634	478	99	2026	421	131

EXHIBIT 7

CAPITAL INVESTMENT AT SELECTED LOCATIONS
CANADIAN AIR TRANSPORTATION ADMINISTRATION
-As of March 31, 1970-

($ 000's)

Site	Airport Facilities	Air Navigation Facilities
EASTERN AREA		
Frobisher Bay	$ 11,282	$ 1,844
Fort Chimo	4,759	663
Inoucdjouac	-	694
Nottingham Island	-	245
Poste de la Baleine	-	153
Resolution Island	-	102
CENTRAL AREA		
Churchill	$ 7,093	$ 2,200
Coral Harbour	4,948	854
Baker Lake	660	2[illegible]3
Resolute Bay	582	628
Chesterfield Inlet	-	635
WESTERN AREA		
Whitehorse Airport	$ 10,019	$ 785
Inuvik	7,283	655
Watson Lk. Airport	5,746	287
Yellowknife	4,289	802
Norman Wells Airport	4,290	511
Hay River	3,259	240
Fort Smith	2,948	444
Cambridge Bay	2,122	1,160
Teslin Airport	1,394	297
Aishihik Airport (closed)	1,162	135
Snag Airport (closed)	706	171
Fort Simpson	714	493
Rou Lake Flight Strip	523	-
Fort Resolution	448	240
Wrigley Airport	381	90
Squanga Lake Flight Strip	330	-
Pine Lake Flight Strip	319	-
Sachs Harbour	280	56
Burwash Airport	250	579
McKenzie River Project	236	-
Carol Flight Strip	124	-
Fort Providence Aerodrome	123	8
Dawson Aerodrome	29	169
Mayo Aerodrome	2	206
Coppermine Aeradio Stn.	-	389
Fort Good Hope	-	341
Contwoyto	-	109

EXHIBIT 8

EXPENDITURES

Northern Roads Program - 1965/66 to 1969/70

($ 000's)

CAPITAL

Area	1965/66	66/67	67/68	68/69	69/70	TOTALS
NWT	1,560	4,004	2,609	3,097	4,290	15,560
YUKON	2,682	3,051	5,230	3,316	5,234	19,513
TOTALS	4,242	7,055	7,839	6,413	9,524	35,073

OPERATIONS MAINTENANCE

Area	1965/66	66/67	67/68	68/69	69/70	TOTALS
NWT	439	295	888	604	676	2,902
YUKON	905	1,157	1,121	1,344	1,184	5,711
TOTALS	1,344	1,452	2,009	1,948	1,860	8,613

EXHIBIT 9

REVENUES

Related to the Use of Northern Roads

($ 000's)

NWT

Source	1965/66	66/67	67/68	68/69	69/70	TOTALS
Fuel Tax	294	370	405	609	690	2,368
Motor Vehicle Licences	85	106	116	175	197	679
TOTALS	379	476	521	784	887	3,047

YUKON

Source	1965/66	66/67	67/68	68/69	69/70	TOTALS
Fuel Tax	533	596	769	1,434	1,470	4,802
Motor Vehicle Licences	228	237	275	376	495	1,611
TOTALS	761	833	1,044	1,810	1,965	6,413

EXHIBIT 10

CAPITAL EXPENDITURES
by
ROAD CATEGORY

Northern Road Program (1965/66-1969/70)

NORTHWEST TERRITORIES ($ 000's)

Road Classification	1965/66	66/67	67/68	68/69	69/70	TOTALS
Communication & Network Roads	(1) 1,560	3,930	2,500	2,998	4,211	15,199
Lateral Roads	-	73	109	99	80	361
TOTALS	1,560	4,003	2,609	3,097	4,291	15,560

YUKON

Road Classification	1965/66	66/67	67/68	68/69	69/70	TOTALS
Communication & Network Roads	(1) 2,682	3,006	5,217	2,714	4,056	17,675
Lateral Roads	-	45	13	602	1,178	1,838
TOTALS	2,682	3,051	5,230	3,316	5,234	19,513

(1) Includes Lateral Roads' expenditures.

EXHIBIT 11a

Expenditure & Revenue Data

Meteorological Services in the North

EASTERN AREA ($ 000's)

SITE	1965/66 O&M.	1965/66 CAP.	1965/66 REV.	1966/67 O&M.	1966/67 CAP.	1966/67 REV.	1967/68 O&M.	1967/68 CAP.	1967/68 REV.	1968/69 O&M.	1968/69 CAP.	1968/69 REV.	1969/70 O&M.	1969/70 CAP.	1969/70 REV.
Frobisher Bay	126	18	7	181	-	-	132	8	-	148	10	-	202	151	-
Cape Dyer	26	-	1	29	-	1	30	-	1	31	-	1	45	-	1
Hall Beach	86	-	1	98	-	1	92	-	1	75	9	1	99	4	1
Clyde River	203	16	-	208	41	1	132	8	2	128	-	2	168	-	3
Inoucdjouac	-	-	-	106	-	1	96	-	2	173	4	2	162	-	4
Fort Chimo	70	1	1	81	206	1	59	14	4	53	1	4	88	-	6
TOTALS	511	35	10	703	247	5	541	30	10	608	24	10	764	155	15

CENTRAL AREA

EXHIBIT 11b

SITE	1965/66 O&M.	1965/66 CAP.	1965/66 REV.	1966/67 O&M.	1966/67 CAP.	1966/67 REV.	1967/68 O&M.	1967/68 CAP.	1967/68 REV.	1968/69 O&M.	1968/69 CAP.	1968/69 REV.	1969/70 O&M.	1969/70 CAP.	1969/70 REV.
Alert	94	80	2	93	47	3	92	105	2	82	10	-	118	15	5
Arctic Bay	8	-	-	8	-	-	8	-	-	8	-	-	8	-	-
Baker Lk.	70	31	3	75	19	-	75	9	-	53	-	-	14	-	-
Churchill	-	3	-	135	2	1	129	8	1	119	10	1	165	-	1
Coral Hbr.	55	4	1	62	9	1	63	-	1	69	1	0	73	5	-
Ennadai	-	32	1	-	32	2	-	-	-	-	-	-	-	-	4
Eureka	86	27	2	75	11	2	74	15	1	101	10	2	113	14	[illegible]
Isachsen	88	17	2	76	7	2	99	16	2	163	10	2	185	10	2
Mould Bay	78	176	2	86	7	2	146	71	2	182	195	2	134	106	1
Resolute	100	15	2	80	1	2	82	3	2	84	3	2	134	11	1
Spence Bay	1	-	-	1	-	-	1	-	-	1	-	-	1	-	-
TOTALS	580	385	15	691	135	15	769	227	11	862	239	9	945	161	15

EXHIBIT 11c

Expenditure & Revenue Data.

Meteorological Services in the North.

WESTERN AREA ($ 000's)

SITE	1965/66			1966/67			1967/68			1968/69			1969/70		
	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.	O&M.	CAP.	REV.
Aishihik	20	-	-	9	-	-		-			-			-	
Beaver Cr.		-			-			-		2	-	-	5	-	-
Burwash L.		-		-	1	-	.1	.1	-	.4	-	-	1	-	3
Cambridge Bay	37	9	3	35	-	2	38	4	2	43	177	1	62	188	1
Cape Parry	31	-	2	28	-	1	30	-	1	33	-	1	36	-	1
Coppermine	60	1	1	54	-	1	82	2	2	100	-	2	140	-	4
Contwoyto	31	-	-	20	-	-	20	-	-	23	-	-	23	-	-
Dawson	.4	-	-	.2	-	-	-	.3	-	.2	-	-	.2	-	-
Ft. Good Hope	1	.3	-		-			-			-		.2	-	-
Ft. Reliance	36	-	-	48	-	-	54	1	1	63	126	3	66	12	2
Ft. Resolution	1	-	-	-	2	-	-	3	-	.2	.3	-	.3	.1	-
Ft. Simpson	10	-	-	10	-	-	10	-	-	10	-	-	13	-	-
Ft. Smith	106	7	7	86	2	5	87	166	5	107	3	4	132	-	8
Hay River	.4	-	-	.1	-	-	11	-	-	9	-	-	11	-	-
Haines Jcn	.1	-	-		-			-		.1	-	-	1	-	-
Holman Is.	1	-	-	1	-	-	1	-	-	1	-	-	1	-	-
Inuvik	95	-	-	72	-	-	81	9	-	86	2	-	138	3	-
Mayo	.3	-	-	.1	.5	-	.2	2	-	-	5	-	.1	-	-
Norman Wells	75	10	4	73	1	2	91	6	3	77	4	5	127	1	6
Old Crow		-			-			-			-		-	2	-
Pt. Radium		-			-		1	1	-	2	-	-	10	-	-
Rea Point		-			-			-		-	5	-	.4	.3	-
Sachs Hbr.	142	47	1	180	156	1	180	8	3	183	6	5	212	7	8
Snag	.1	-	-	-	.4	-		-			-			-	
Teslin	1	-	-	.2	-	-	.1	1	-	.4	.1	-	.1	-	-
Tuktoyaktuk		-			-			-			-		-	1	-
Watson Lk.	38	4	3	32	-	2	36	1	3	36	2	3	50	16	4
Whitehorse	215	1	-	206	1	-	209	1	-	213	25	1	280	6	1
Wrigley	.1	-	-		-		.1	-	-	.1	-	-		-	
Yellowknife	63	-	-	54	1	-	56	9	-	54	1	-	71	2	-
TOTALS	963	79	21	909	165	14	988	213	20	1043	356	25	1380	238	38

EXHIBIT 12

Canadian Federal Government
Transportation Related
Expenditures & Revenues
in the North.

1965/66 to 1969/70.

($000,000's)

Mode or Service	1965/66		1966/67		1967/68		1968/69		1969/70	
	Exp.	Rev.	Exp.	Rev.	Exp.	Rev.	Exp.	Rev.	Exp.	Rev.
AIR	9.1	1.08	9.2	0.94	5.5	0.90	11.8	1.06	13.7	2.09
MARINE	8.5	3.75	9.5	3.37	9.5	5.38	11.6	4.36	11.6	5.81
ROADS*	10.9	1.14	14.5	1.31	17.2	1.57	17.1	2.59	20.9	2.85
METEORO-LOGICAL	2.9	0.05	3.4	0.03	3.5	0.04	3.9	0.04	4.5	0.07
TOTALS	31.4	6.02	36.6	5.65	35.7	7.89	44.4	8.05	50.7	10.82

*- Revenues accrue to the Territorial Governments.

TRANSPORT FACILITY COSTS AND USER CHARGES

BY: MR. E.T. HAEFELE
Resources for the Future, Inc.

User charges may be used for a variety of purposes--to pay (or help pay) for a facility; to ration use of the facility; to provide a threshold cost effect; or simply as a revenue-producing device unrelated to any particular set of costs. In the context of northern transport I shall assume that only the first of these purposes has meaning and I shall, therefore, ignore the rest. I will, however, interpret user charges not simply as a way of paying for operating expenses but also as a possible way to recover capital costs of transport facilities, as indeed it is in private market transactions. Thus the questions I pose are the traditional questions--is it possible for northern transport to pay its own way and implicitly, is it desirable that it do so?

It will be useful at the outset to clear away the field we would examine so as not to become entangled in the brambles of misunderstanding about what the ground is. First, though micro-economic theory tells us that it is optimal to have each economic decision unit deciding on the basis of an "all costs included" policy (including social costs somehow allocated), that fact should not stampede us into accepting a 100 percent user charge system for northern transport. Second, even though some of

the "decision-units," hereafter called companies, may wish us to believe that unless transport facilities are provided at government expense, no investment will take place, that fact should not be a compelling reason to provide a single facility. In other words, we stand in a policy area in which government investment criteria, timing and strategy are crucial yet cannot be fixed by reference to a single, simple rationale.

It will be the contention of this paper that government investment policy toward northern transport facilities cannot be decided within a transport framework at all, but only in the broadest framework of national policy and goals in education, social welfare, and economic development. Before moving to those lofty realms, however, it is necessary to return to the lowly user charge and see why it has such seeds of greatness within it.

It will be obvious to you that we bear transport user charges in our everyday world as a matter of course. We pay gasoline taxes, parking fees, our "share" of landing fees. We pay freight charges and buy airplane tickets. All are user charges. When they are levied by any private company they are designed to aggregate, in toto, an amount equal to the costs of providing the service, or at least they should be so designed if the company wishes to stay in business. When they are levied by any transport business, they probably also bear some nominal relationship to the costs of providing the services,

at least they do if the regulatory agency is living up to its responsibilities. Immediately, however, we are faced with a choice. While a totally unregulated business may price its services in response to a demand function, capturing as much of the available consumer surpluses as it can, a regulated transport company may be forced away from what was once called a "value-of-service" pricing policy to some pseudo-cost based pricing policy. The latter may fall out as an "average cost" pricing policy or some approximation to a "marginal cost" pricing policy.

Without going into the mysteries and metaphysics of these two policies, it is sufficient to say that regardless of which it pursues, the quantity demanded in relation to capacity is of preëminent influence on the level of its unit costs. Were I the only user of the Washington-Edmonton air service the user charge would have prohibited my attending this conference. Indeed, service would scarcely exist between the two points were it to depend on the volume of traffic between the two points. What happens, of course, is that I go via Chicago, or New York, or Toronto and then to Edmonton, sharing in the costs of these runs which are mostly borne by people who do not want to go to Edmonton. I add little or nothing to capacity requirements but contribute my equitable (as defined by the regulatory agencies) share of revenue to the airlines.

Now, this system works reasonably well in a developed area, with multiple centers of commerce and high demand for service from different

groups. Peaks and troughs of demand are smoothed out and economies of scale are realized. Contrast such a world with the world of northern transport with its feast or famine character, its ten to 1 ratio of north to south freight movement and its seeming inability to take advantage of any agglomerative economies. Having made such a contrast, think it possible, therefore, that user charges in the North may not be quite so efficacious as a resource allocator.

Reality is yet more harsh than the simple contrast would imply. It is not only that the decreasing unit cost characteristics of most transport modes cannot be exploited now, but that the pattern of settlement is such that agglomerative economies in almost all governmental areas can never be realized. To make the point more specifically, I reproduce two sets of figures. The first was compiled by Werner Z. Hirsch[1/] and relates to the supply of urban services.

Figure 1

Cost Curves for Urban Services

Service	Shape of Average Unit Cost Curve
Secondary education	U shaped with trough at about 1,700 pupils
Primary education	horizontal*
Police protection	horizontal*
Fire protection	declining
Electricity	declining
Sewage plants	declining
Gas	declining

*ignoring some threshold costs which, when included, make the curve a declining one for the relevant range.

1/ Werner Z. Hirsch, "The Supply of Urban Public Services," in Issues in Urban Economics (ed. by Perloff and Wingo), Johns Hopkins Press (Baltimore), 1968. p. 508.

The second set of figures comes from a study by Rogers and Jones[2/] and gives us an overall look at the size of settlements in the North.

Figure 2

Percent of Area Population Living in Different-sized Settlement

Size of town	Interior Alaska	Yukon territory	S.E. Alaska	N.W. B.C.	N.W. Alaska	NWT	S.C. Alaska	N.E. B.C.
10,000 and up	81			31			74	10
2,000-10,000		34	67	37	15	14	5	13
1,000-2,000			8		12	19	6	6
Under 2	19	66	25	32	73	67	15	70
Totals	100	100	100	100	100	100	100	99*

*does not add to 100 due to rounding.

Since the Hirsch compilation was made primarily from data from cities above 10,000, it tends to discount the scale diseconomies at the "far left" of the cost curve and hence, if anything, understates the cost disadvantages of providing services in settlements under 10,000.

2/ G. W. Rogers and D. N. Jones, <u>Alaska-Northwest Canada Economic Activities</u>. Part II. Federal Field Committee for Development Planning in Alaska (Anchorage), 1968.

The Rogers and Jones data indicate how very prevalent such small towns are in the North. We may surmise from these data that companies, investors, governments, and transport services all suffer from high unit costs which are exacerbated by the settlement pattern. I refrain from expanding the point to include the clear social disadvantages of small, one-company towns and the miseries connected therewith.

With the problems and economic costs of dispersed settlements at least alluded to, we can focus on user charges for transport facilities in a proper context. Were we to have a firm and consistent governmental policy of encouraging fewer, hence larger, settlements in the North, it is feasible, it seems to me, to make use of transport user charge schemes to recover some, if not all, of the cost of government investment in transport facilities. If we do not successfully pursue such a policy, it seems certain to me that no user charge scheme will succeed. In this judgment, I am not intending to include cost-sharing arrangements for the building of airstrips or roads. These latter arrangements can, however, have the perverse effect of encouraging "scatteration" of settlements by artifically reducing the costs to industry. The result, for government, is not only an additional expense for an uneconomic transport pattern but also additional expense in all other governmental service areas.

It is worth exploring what a more concentrated settlement pattern might look like and what transport implications it would have. In some areas it is easy. Whitehorse has a clear edge in the Yukon Territory. New mining developments in the Territory could have been handled from Whitehorse, with families living in Whitehorse and workers transported to and from the mining areas, probably on a daily shift basis. Transport user charges on all modes from the outside world to Whitehorse is obviously feasible. In large measure it occurs now. Transport from mines to Whitehorse could be totally a company expense. Whitehorse facilities, themselves, could very probably be on a user charge scheme under such assumptions. It is not at all obvious that such arrangements would be more expensive for the companies than the more usual pattern of establishing a company town at or near the mine site. Figures supplied to me privately indicate that the capital costs and slow recovery rates for town sites in remote areas are not bargain solutions. Even less are the company towns bargain solutions if the life of the mine is short, as many are, or if the need for personnel is temporary, as is the case on the North Slope of Alaska and indeed, for much of the Arctic oil phenomenon.

There may be three or four other such centers throughout the North. Caution and simple prudence prompt me not to identify them.

They represent the far end of the user charge spectrum. From Whitehorse and these other centers outwards to markets, a self-sustaining transport system can be postulated with some confidence. From Whitehorse and the other centers inwards to sources of raw materials, the transport system is primarily a calculation in some company's economic calculus. Here government investment in transport, if made, is unlikely to be recoverable by a user charge scheme. Government should calculate here as a company would. If it has social welfare responsibilities, for some time period, in some area, it should try to share transport costs with companies that also have some temporary transport requirements. It should avoid, just as the companies do, any on-going or general responsibility for "taking over" facilities or services. These facilities would, in my terms, not be public at all and hence not treated in the way "public" facilities are treated in law and transport regulations.

It is no sure thing that a self-supporting transport system can be brought up as far as four or five centers north of present, continuous settlement lines. Many would argue that transport is not now self-supporting anywhere in Canada or the United States. I do not mean to presume an answer to that question. I assert instead that even if it is not, nationally, it could be without loss of any essential service. I assert further that it is possible to imagine that with

concentration of population in the North, the transport system could even be self-supporting to four or five centers in the North. User charges thus could play a role that far. Beyond these points, I submit there is no possibility of self-support of a general system or network and that services, both public and private, should be provided or not depending on company calculation and/or governmental requirements in non-transport areas.

Any reasonably perceptive reader will by now be thoroughly exasperated by my use of "postulate" and "assert" in the last few pages. The truth is, however, that practically no studies exist which could allow me to furnish my assertions and postulates with numbers either supporting or refuting them. If the Canadian government is concerned with transport user charges, as a practical matter it should be trying to generate some of the numbers. We could then answer the question "is it possible?"

That question would not give us an answer to the policy question "is it desirable?" For that answer we must go deeper into the larger areas of national goals and national priorities in Canada. That this is necessarily so should now be apparent from the preceding pages. National policy is not necessarily set by an economic criterion and that is all that the "is it possible?" question can furnish. I do not intend to presume upon the Canadian policy questions in substance. I say only that it is legitimate to use transport as a means to

accomplish non-transport ends. When it is done, transport is not measured by its financial self-sufficiency but by whether the cost is worth the end accomplished. Transport experts can calculate the costs. They have nothing relevant to say about their worth.

TRANSPORTATION FACILITY COSTS AND USER CHARGES

BY: Mr. K. Wyman
Research Division, Canadian Transport Commission

According to Section 15(g) of the National Transportation Act, the Canadian Transport Commission has the obligation to "establish general economic standards and criteria to be used in the determination of federal investment" in transportation equipment and facilities "and in the determination of desirable financial returns therefrom". Section 15(h) adds that the CTC is to advise the federal government "on measures to develop revenue from the use of transport facilities provided or operated by any government department or agency". The approach of this paper is to consider briefly, in the light of the National Transportation Act, the contribution that economic theory can make to the development of general economic standrads and criteria relating to user charges on federal transportation facilities, with some examples being drawn specifically from the situation in the Yukon and the Northwest Territories.

I

The literature of economic theory with respect to user charges (they are usually referred to as 'prices' by theorists and also by the general public) can be divided, broadly speaking, into two schools of thought. The first school of thought emphasizes what might be called the 'free enterprise' ideal, which assumes that the economic welfare of the community as a whole is best served by a system of well-functioning

competitive markets in which prices play a vital role in determining the allocation of scarce resources to alternative uses. The second school of thought has in common the rejection to a greater or lesser extent of the free enterprise ideal in favour of bureaucracy as the appropriate means of making the most important allocation decisions. Even in the nineteenth century, the bureaucratic ideal was more influential than is sometimes realized, and certainly in recent decades it has been reflected in the marked expansion of government activities in all western countries, including Canada.

The free enterprise school of thought owes its intellectual origins to the writings of Adam Smith and of the English economists in the classical trafition during the nineteenth century. The nineteenth century version of the free enterprise ideal still has some distinguished twentieth century exponents, such as Professor Milton Friedman of the University of Chicago. Basically, it would confine the role of the state to the maintenance of justice and civil order, defence against external enemies, and a limited range of other responsibilities. The provision of transportation facilities and other forms of social overhead for economic purposes would be provided mostly by private enterprise firms, operating in well-functioning competitive markets, and seeking, where demand permits, to recover both capital and operating costs by means of prices

(user charges) levied on those who benefit directly from the facilities provided.

Prior to World War Two, the federal government's role in the Yukon and the Northwest Territories bore all the marks of the narrowest interpretation of the free enterprise ideal, as outlined above. Government expenditures were largely restricted to safe-guarding law and order and administering justice. For the most part it was left to private enterprise to determine the pace of investment in transportation facilities and other social overhead capital, which was generally very slow. Had it been thought necessary to do so, the federal government could have tried to justify its inactivity in the northern Territories by invoking the intellectual authority of Adam Smith and the English economists of classical tradition. Long before World War Two, however, the federal commitment to the free enterprise ideal was much less than complete where transportation facilities below the 60th parallel were concerned. This is clearly indicated, for example, by the substantial subsidies that were extended in the late nineteenth and early twentieth centuries to the construction of three east-west transcontinental railway systems in Canada.

The validity of the free enterprise ideal of cost recovery through user charges depends, among other things, on the assumption that a system of well-functioning competitive markets is compatible with the achievement by the firms which operate in these markets of all possible

economies of scale. A well-functioning competitive market, in this context, can be defined as a market which consists of a large number of sellers and buyers, none of which is in a position to exert a significant degree of monopoly power over prices.

One variant of the free enterprise ideal, which has gained some support in recent years, concedes, on the one hand, that the economies of scale associated with modern technology or sales promotion may require a high degree of monopoly power in many markets if lowest possible unit costs are to be achieved. On the other hand, the assumption is made that if, because of economies of scale, it is desirable in the public interest that a project should be carried out by the state, then the role of the state should be to simulate conditions which it is assumed would exist in a well-functioning competitive market. With respect to charges on transportation facilities, this implies that government should act in a 'business-like' way, where demand permits, to recover both capital and operating costs on facilities it provides by means of user charges levied on those who benefit directly.

In the case of the Northwest Territories, the Northern Transportation Company provides an example of a government enterprise which appears to operate on the basis of the variant in the free enterprise ideal mentioned above. This

Company is a crown corporation having its head office located in Ottawa and its operations office at Edmonton. It has a near-monopoly position as a common carrier of freight on the Mackenzie River system, from Hay River to Tuktoyaktuk, N.W.T., on the Arctic Coast. In addition, the Company provides service to the central Arctic coast, east and west of the mouth of the Mackenzie River, and to the lower Arctic islands. It has relied wholly on cost recovery from user charges since it came under crown ownership, and has not had any direct subsidies from public funds for operating or capital purposes, although there have been indirect subsidies, for example in the form of aids to navigation provided on the Mackenzie River system by the marine administration of the Department of Transport. Despite reductions in its tariffs from time to time, the Company has shown a net profit after taxes in 24 of the 26 years (1944 to 1969 inclusive) since it became a crown corporation.

II

Since World War Two, the extent of transportation expenditures by the federal government in the Yukon and the Northwest Territories has increased considerably. During the 1940's and 1950's this was due in part to Canadian participation in Continental defence arrangements with the United States, examples being the Alaska Highway, the

DEW line and the Mid Canada line projects respectively. There has also been an increased federal readiness, particularly during the 1960's, to invest in Northern transportation facilities as a means of encouraging economic development in general, and especially resource development.

The Northern Roads Network Programme, announced in 1965, has resulted in an average capital expenditure of nearly $10 million a year during the period 1965-66 to 1969-70, which is nearly double the annual roads investment of the previous ten-year period. There have also been substantial federal expenditures in recent years on airports and air navigation services, meteorological services, and marine services, relating to the northern Territories. The Great Slave Lake Railway is another major example of Federal investment related to resource development in a part of the northern Territories, amounting to $74.8 million at April 1, 1969.

The growth of federal transportation investments in the northern Territories has involved a substantial departure in recent years from the free enterprise ideal that only those investments are justified where demand permits the recovery of all costs - both capital and operating - from charges levied on those who benefit directly

from the facilities provided. At the present time, there is a considerable gap between costs and revenues derived from user charges on federal transportation facilities in the northern Territories, with the balance being made up by means of general taxation.(1) The growth of this gap in recent years implies a questioning by the federal government of the assumptions on which the free enterprise ideal is based. There would appear to be a reluctance to accept the principle of cost recovery through user charges as a practical guide to policy-making, both with respect to decisions about new transportation investments in the northern Territories, and with respect to the pricing of existing facilities.

For purposes of this paper, it may be useful to mention briefly three assumptions which might be used to justify down grading the role of user charges with respect to federal transportation investments in the northern Territories. In the first place, the case against user charges - and for subsidy - might be justified on the assumption that subsidies are desirable, in the public interest, to accelerate the rate of economic development in general, and the rate of resource development in particular, beyond that which is likely to be achieved by private enterprise operating exclusively on the basis of cost recovery through user charges.

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1. One important exception is the Great Slave Lake Railway which, in the last six months of 1969, had operating revenues greater than its operating expenses plus depreciation.

Secondly, the case for government subsidy might be influenced by the assumption that it is desirable, in the public interest, to take into account certain indirect benefits which would not be adequately reflected by the prices arrived at in the market. Most important in this regard is the growing emphasis in recent years on the need to protect Canadian sovereignty in the Northern Territories by means of larger investments in transportation and other facilities even where these may not be able, at least in the short run, to cover total costs through user charges. Thirdly, departures from the user charges principle might be justified in some cases by the assumption that it is desirable to use transportation subsidies as a means of redistributing income to the indigenous population of the northern Territories.

III

Each of the assumptions outlined above may have some validity in terms of justifying departures from cost recovery through user charges on government transportation facilities in the northern Territories. However, each needs to be viewed with caution, both from the standpoint of the Canadian community as a whole and from the standpoint of the consumers of these transportation facilities in the northern Territories.

From the standpoint of the Canadian community as a whole, it is important to ensure that departures from the user charges

principle on transportation facilities in the northern Territories are made only after the most careful consideration possible of the benefits and costs of the alternative transportation or other opportunities that may exist in the country, no matter on which side of the 60th parallel they may be located. This is especially important because of the scarcity of available capital in relation to alternative opportunities. J.W. Pickersgill put this point as follows, in an address in 1969 to the Arctic Institute of North America:

> "We in Canada are faced with the problem that the distances we have to cover are tremendous in relation to the size of our population. We cannot necessarily afford to invest in every transportation project which seems to have merit without considering the total possibility for investment and the total funds available. It may very well be that for the forseeable future, investments in depressed but populated regions of the country may bring higher returns to the economy as a whole than investments in what are now undeveloped, virgin territories. But questions like that cannot be answered staisfactorily without knowledge of both in order to make valid choices".

Even the most knowledgeable system of national transportation planning could not, of course, completely eliminate the competition for scarce government funds between the consumers of transportation or other facilities above the 60th parallel and those in the rest of Canada. On the other hand, once the level of government subsidy is taken as given to transportation or other facilities in the northern Territories, then consumers both above and below the 60th parallel do share a common interest in ensuring that all government programmes are co-ordinated as

much as possible in order to achieve the desired objectives at the lowest possible cost in terms of real resources.

Thus, if the objective is taken to be the promotion of economic growth, then it would appear to be in the interest of all consumers to ensure that all modes of transport represented in the northern Territories--rail, water, air or road--be considered on an equal basis with respect to subsidies. Otherwise, traffic may in some cases be allocated to higher cost modes, with the result that a given level of subsidy does not make the maximum contribution possible to economic growth. In this regard, it may be noted that at the present time transportation facilities provided by the federal government in the northern Territories are not always treated equally with respect to the availability of subsidies. For example, road and air facilities have been subsidized wheras we have already noted that the Northern Transportation Company, which is a crown corporation operating on the Mackenzie waterway system, is expected to recover its direct costs from user charges.

To the extent that the federal government departs from the user charges principle in the pricing of northern transportation facilities, it will have to assign priorities, implicitly or explicitly, between objectives where these may conflict. The considerations that should influence the choice of objectives is obviously beyond the scope of this paper to discuss in detail.

However, one question which is of significance is the extent to which the objective of economic growth should be given high priority. On the one hand, the mining and oil companies will make a strong case for subsidizing resource exploitation on grounds of promoting economic growth. On the other hand, there may be costs of resource exploitation, for example from the standpoint of the welfare of the native population and also from the standpoint of environmental control. Transportation is essentially an intermediate good, and subsidies to this industry in the northern Territories will inevitably reflect the priorities that are assigned by the planners, implicitly or explicitly, to objectives which may conclict.

It is necessary to view with caution the case that is sometimes made on grounds of income distribution for departing from the user charges principle in the pricing of government transportation facilities in the northern Territories. On the one hand, there is no doubt that the living standards of the indigenous population in the northern Territories falls well below the national average. On the other hand, it is worth recalling that the indigenous population of the northern Territories is extremely small. Each of the provinces could probably count more people in its most impoverished areas.

Furthermore, aid given specifically in the form of transportation subsidies may not always be the best way of raising the living standards of that part of the Northern population which is most in need. Two points seem relevant in this regard. In the first place, it is not necessarily true

that poor people are the principal beneficiaries of subsidized transportation facilities, merely because they happen to live in the areas covered by these subsidies. Secondly, aid given specifically in the form of departures from the user charges principle may weaken the ability of the price system to allocate scarce resources efficiently to alternative uses.

The case for subsidizing transportation and other facilities in the northern Territories on grounds of national sovereignty has been receiving increased attention in recent years. Here, too, it may be useful to introduce a note of caution. Even if the objective of protecting our national sovereignty is accepted as deserving priority, there still remains the question of the extent to which federal investments in the North are likely to realize the highest returns in terms of this objective.

Given the scarcity of available capital within Canada, federal investments in transportation or other facilities above the 60th parallel may reduce opportunities for reducing the present high degree of non-resident ownership in manufacturing and resource industries, in southern Canada, which some might regard as an equally if not more important threat to our national sovereignty than the failure of Canadians to invest more rapidly in the development of the northern Territories. It may be possible to lessen the opportunity cost to the extent that non-resident direct investment is relied on for exonomic development in the northern Territories, but some Canadians are becoming

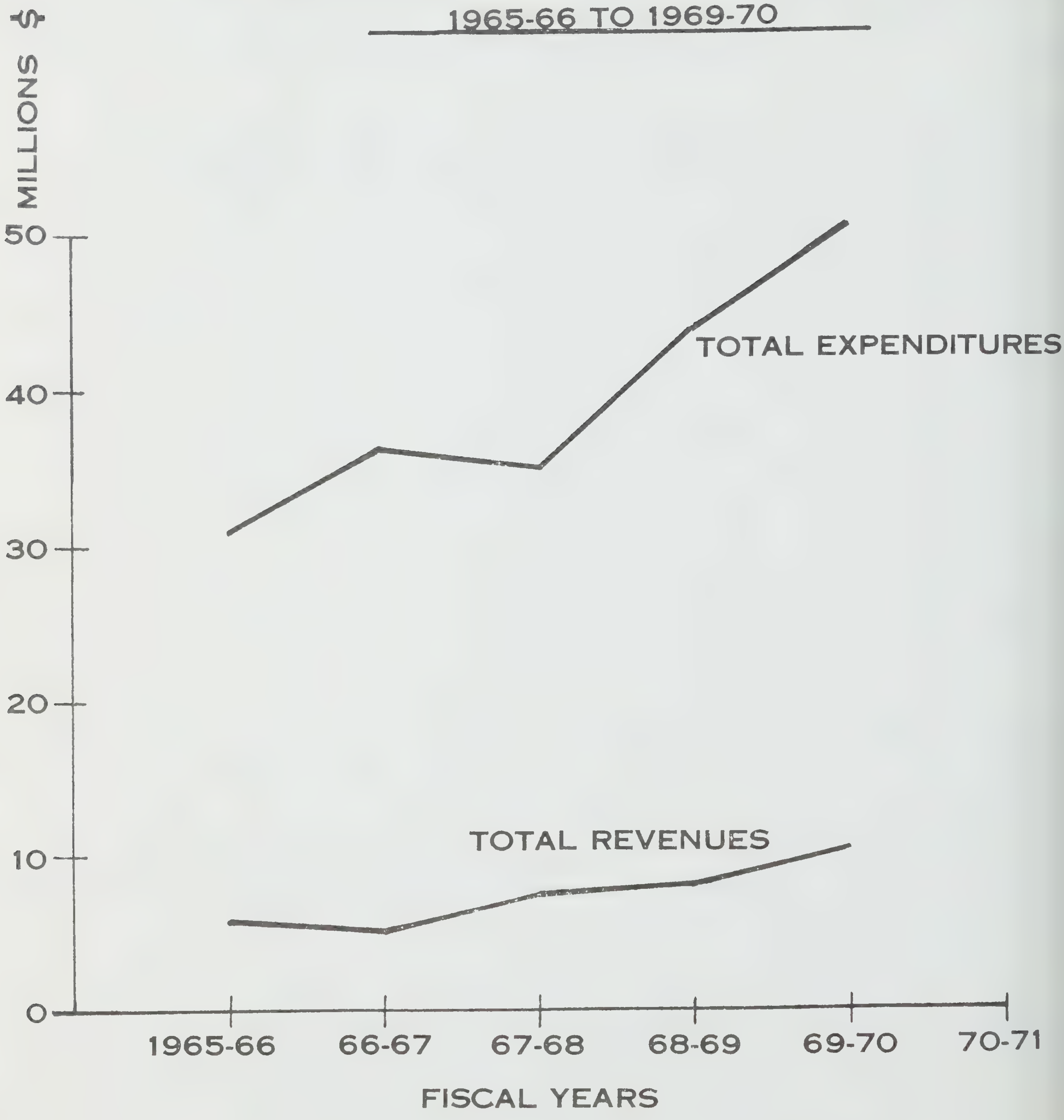
increasingly skeptical about reconciling our present heavy reliance on non-resident direct investment with the protection of our national sovereignty, whether above or below the 60th parallel.

IV

In conclusion, the main point which is suggested in this paper is the need to view with caution the various assumptions that are put forward to justify departures from the user charge principle in the pricing of government transportation facilities. This point applies both above and below the 60th parallel. It is not, of course, suggested that all departures from the user charges principle are unjustified in the national interest. What is suggested is that too often, critics of the principle of full cost recovery through user charges seem to be making an implicit comparison with an ideal, all-wise government bureaucracy, ready to take into account all social costs and benefits, able to forecast with perfect certainty the means of achieving the soically optimal rate of economic growth, and capable of determining a socially 'ideal' distribution of income. Such a comparison is, to say the least, itself open to question.

EXHIBIT 2

FEDERAL GOVERNMENT EXPENDITURES & REVENUES
AS RELATED TO TRANSPORTATION IN THE NORTH
1965-66 TO 1969-70



(REFERENCE EXHIBIT 12)

SOME THOUGHTS ON USER CHARGE POLICY FOR NORTHERN TRANSPORTATION

BY: P. J. DETMOLD
Special Assistant, Research Department, Canadian Pacific Railways

My first thought when I was asked to produce this paper was to wonder how the application of user charge theory requires modification when applied in a Northern context.

In a transportation system in a developed region there is no reason why transportation facility charges should not reflect the cost of their provision. User charges might then be expected to equate the supply of transport and its demand and thereby to achieve some optimal allocation of resource use.

But such words as 'optimal' and 'cost' may refer to optimisation from the community standpoint and to community costs or they may be applied to the more limited standpoint of transport users.

The essential truth here is that micro economic analysis of this kind is capable of linking the allocation of resources with the attainment of objectives. The essential question concerns whether it can do so when the objectives cannot be defined in purely economic terms; that is to say when in place of the objectives of profit or of community benefit is substituted the attainment of national goals.

If some user charge system can be derived which, with greater or lesser amounts of government assistance, can simulate the market function to an extent where each individual operator whilst pursuing his self-interest can combine to achieve efficient resource use, then Northern Transportation can develop with the

essential flexibilities of private enterprise and with a minimum of regulation.

Before developing this theme, however, I feel it essential to digress as I am conscious of having used the term 'profitable' in a loose way and of having assumed unprofitability for Northern transportation without explanation.

If sufficient capital is injected into an area in investment in industry, transportation, and other community services, then a point must surely be reached at which individual services become self-supporting. Put in another way, if sufficient capital is available and the discount rate is sufficiently low, the Northern economy may be expected to 'take off' with very small assistance from the government.

At the time of the construction of the Canadian Pacific Railway, the financial validity of the project can have appeared little more favourable - if more favourable at all - than many Northern transport projects do today. But before many years a strong self-supporting company had developed. In other cases - the Canadian Northern Railway, for example - the infant was not so healthy and only survived after numerous governmental blood transfusions.

I do not intend to analyse those characteristics of either company which contributed to success or to failure, but merely to point to the importance both of co-ordination between transport and other investment and of the dynamic nature of the

investment problem.

Enterprises which are strong from the outset generate internally or attract externally the capital resources needed for their continued development; they attract expertise capable of planning the extension of their route system with intelligence. Less prosperous concerns tend to erode their capital in meeting operating deficits; as their abandonment would probably have serious repercussions on the community, they rely on government support and become a continuous drain on resources.

There are, broadly, two alternative courses of action. In the first the government can, if it wishes, analyse the transport needs of the developing Northern communities and then procure the services it considers necessary; in the second it could inject the capital needed in the most favourable of projects proposed by private interests and provide improvements to airports and highways as and when the need for these became apparent from the developing traffic flow.

At first sight the first of these seems much to be preferred. Provided that some omniscient authority can handle an optimisation problem that involves community development and land use, the distribution economy of each industry, the economy - considered in full technical detail - of road, rail, air, river and pipeline transportation and which requires a fully dynamic treatment of capital development, then it can hardly fail to succeed in determining the optimal route and service structure

for an integrated transport system. By 'an omniscient authority' I do not refer to a number of separate departments of government - some of them subdivided into semi-autonomous agencies - working together in some committee structure. This is one problem with numerous interdependencies of the multivariate factors involved and defies solution by other than one powerful interdisciplinary team working together in one place.

What of the alternative? Private enterprise cannot provide as neat and tidy a solution as a systems study of the very highest quality; but it may provide a much less disastrous solution than that derived from a series of studies each of some part of the problem, even if it could be assumed that they were all of the highest quality.

How would such an approach be formulated? First one should consider the requirements of a facilities cost and user charge system appropriate to the development of a free enterprise system. The order in which they are listed implies no scale of relative importance.

Firstly, there would have to be clear definition of safety and other standards of service appropriate to each mode.

Secondly the operator would have to take a share of the financial risks involved. He would thus have no incentive to propose projects of an absurdly uneconomical kind.

Thirdly the aim would be to acheive financial self-sufficiency as early as possible.

Fourthly there should be minimal interference with the incremental revenue and cost to the operator of carrying each additional unit of traffic. A subsidy per unit hauled encourages industrial development of unsound kinds and involves the government in an open ended commitment; any arrangement which interferes with the operator's incentive to carry traffic of kinds which offer to meet no more than the long run variable cost involved in its movement hampers legitimate development.

Fifthly there should be no inequality of subsidy to one mode compared with others.

Such a system is by no means easy to achieve and I shall offer no recommendation for one system over others.

It does appear, however, that initial capital grants have some advantages over on-going pro-rata payments, provided there are adequate safeguards to ensure that high quality services are operated and in the event of a carrier's bankruptcy. There would be minimal interference with the operator's incentive to develop his business on sound commercial lines and in so doing to contribute to the growth of a strong economy.

I recall the proposal a few years ago that U.S. airlines might bid in an auction for each new route. (The bids themselves might not be very high at present.)

Could not the principle be applied in reverse? Each operator in each mode could state the grant he would require to operate some specified service on each route or group of routes.

Tenders for airport and highway construction or improvement could be considered on the same basis. The government could then carry out or have carried out a cost/benefit study in which the capital cost of each combination of services could be compared with their industrial and community value.

An arrangement of this kind has obvious risks to the government, but it would ensure a high degree of realism in the analysis because the tenderers would be forces to use their entrepreneurial skill in formulating their proposals. It would tap the commercial judgment of the transport industry to a degree that is not readily simulated in theoretical analysis.

I have tried to describe the two approaches in sufficient detail to identify their salient features, but without expressing a preference. No doubt other alternatives could be found by 'fine tuning'.

The point which seems to me to be of overriding importance when formulating user charge policies concerns this basic choice between a transportation system planned centrally and closely regulated with regard to routes, service frequencies, and charges and one which develops with government assistance and between government inspired guidelines, but which permits the maximum latitude for commercial enterprise. The relative merits of the two fundamental alternatives extends far beyond a question of the initial choice between routes and modes and plumbs the depths of Canada's transport philosophy.

To appreciate the difference in full perspective, one has to cast one's imagination some years ahead in order to foresee the kind of transport systems that will have emerged. By the one philosophy a rather more authoritarian system will have grown up than by the other. Transport operators will have tended to become contractors rather than entrepreneurs. As the pattern of trade flow develops and perhaps changes emphasis between one route and another, so one 'system' study will follow another. For the government to disengage itself will become increasingly difficult.

If a more strongly commercial policy is adopted but does not succeed due possibly to capital shortages, then clearly the effect upon the North will be chaotic. If it does succeed and as the need for government support declines, a transport system will have emerged closely resembling that in the more highly developed parts of Canada today and much in the spirit of paragraph one of the National Transportation Act.

What are the characteristics of this development likely to be? This is very difficult to predict, but I shall speculate. First and foremost, as labour costs continue to rise, so will the advantages of scale increase. The cost advantage of the intensively used paved highway, the large unit train, the large aircraft, the super tanker or bulk freighter will increase by comparison with less intensive operations.

This may be expected to favour the larger settlement - the cities of the North - counterbalancing the attractions of rich mineral deposits in isolated situations.

There will, in the very broadest terms, be the counter attraction of the markets of Eastern Canada and the U.S. Mid West on the one hand and the Pacific rim on the other. The first favours the development of a major North West to South East transport corridor based upon the Mackenzie Delta and the valleys of the Yukon, but focussing on Edmonton. The second favours the development of the shortest distance links to tide-water on a North to South axis and suggesting the need for improved port facilities on the adjacent coast.

I shall express no preference for I have not yet seen a sufficiently comprehensive analysis of this central strategic issue to justify any firm conclusion and any premature decision here would be dangerous in the extreme.

To me the essential point is that user charge policies should not bias the choice either between routes or between modes.

There should be minimal interference with the basic economic mechanism for equating supply and demand and for channelling investment funds towards the most favourable activities. Whether this is achieved by highly sophisticated analysis and under governmental direction or whether it is achieved by market forces operating within some simulation of the transportation system in more highly developed areas matters a great deal less

than that it is achieved by whatever means. This should be the ultimate objective of facilities cost and user charge policies.

VOLUME 3

SECTION 3 - NORTHERN RAILROADS AND SOLIDS PIPELINES

CHAIRMAN: M. Archer

PANELISTS: W. W. Collins

A. F. Joplin

R. R. Latimer

M. F. Taylor

V. R. Cox

"Railways destroyed governments, and governments on occasion destroyed railways".

Donald Gordon.

RAILROADS AND SOLIDS PIPELINES IN THE CANADIAN NORTH

BY: MR. W.W. COLLINS
Canadian Surface Transportation Administration

This morning's session, which focuses on both railway and solids pipeline transportation, is viewed by all of us on the panel as a privileged opportunity to explore with you what these modes and the Canadian North may hold for one another as the future of this region unfolds. As a prelude to the other presentations and discussions, I would like to touch, at least generally, on some of the backdrop characteristics of these transportation means as well as the North, and suggest several considerations that would seem to have a significant bearing on the question of "Where from here?".

Railways and solids pipelines share a number of important characteristics. Each can move great amounts of material steadily over long distances. It is now common for single trains to haul payloads well in excess of 10,000 tons apiece. Similarly, large carrying capacities can be designed into solids or semi-solids pipelines: A twelve-inch pipe moving a 40% slurry solution at four miles an hour, for example, can deliver over 7,000 tons of product a day. Both modes can also adapt to a wide variety of weather and terrain circumstances. And, of course, they offer low-cost land transport for bulk commodities, a key advantage especially when value per unit shipped is not high and the movement is large or relatively constant. Their strength in this type of traffic is fundamental,

much as the truck and aircraft tend to specialize in the high-value, service-sensitive shipment.

At the same time, railways and solids pipelines are expensive to put in place, with the cost of construction generally running firmly into the six figures for every mile. In the case of the pipeline, which is essentially its own rolling stock and right-of-way, that is the heart of the capital cost. But for railways, there is also the train; the locomotives and cars that move 10,000 tons at once will be another investment of over $3 million. This overall capital outlay factor, coupled with the reality that a rail or pipe line is effectively committed to a physical location once installed, put two key demands on the traffic to be served. One, that it produce a high degree of utilization for the facility; and, two, that the foreseen duration and volumes of the movement justify what is, for all practical purposes, a geographically sunk decision. Generally, there is only a negligible retrievability of investment if it is wrong.

The individual potentials and strengths of railway and solids pipeline transport are, admittedly, only one side of the coin. On the other are the characteristics of the prospective job and environment against which the advantages and limitations of the modes must be measured.

The variety and expanse of the Canadian North have been

documented extensively, and it is clear that a monolithic description cannot adequately characterize it. Nevertheless, a series of considerations do emerge that are useful in assessing the possible solids pipeline and railway roles. The most pertinent appear to be these:

- the growth of the region's predominant resource base will concentrate, aside from the oil and gas possibilities, in minerals of relatively great bulk and weight, such as lead, zinc, copper and iron. This implies heavy-duty systems for movement.

- the distances both within the North, and to continental markets and tidewater shipping ports are, as a rule, lengthy. Thus transportation is destined to be a prime component, and unit freight costs will have commensurate importance.

- with the likely resource markets, and only modest forecast population and consumption in the North, out-bound shipments will continue to dominate traffic flows and create few backhaul opportunities.

- the extreme climate can hamper construction, operation and maintenance of transport facilities. In addition, conservation concerns and unique environmental conditions pose their own challenges and, in some cases, will limit transportation choices.

This very selective profile indicates the central importance that bulk haulage will assume if the resource predictions for the North are borne out, and suggests that the region may be the next major area for expansion of systems that can perform this service. Climate, distance and, inevitably, the need for dependability, will be Northern factors weighing strongly in the choosing of mode.

At this point in time, the railway presence north of the 60th parallel is limited to two lines that tap the region's southern extremity. The senior of these is the White Pass & Yukon Route, running 111 miles from Skagway to Whitehorse. Completed originally in 1900, the narrow gauge White Pass is carrying forward a vigorous multi-million dollar improvement program on the railway and associated trucking and container-ship services, and is enjoying a traffic resurgence centered on mineral activities. The relative newcomer to the North is the Great Slave Lake Railway, a project of the 1960's. The Great Slave Lake, part of the Canadian National, also has its main

orientation toward resources, the rich lead-zinc deposits at its northern terminus having been the catalyst for the road's construction. Today it forms a link of some 430 miles between this area and a southern connection point on the Northern Alberta Railway, near Grimshaw. A closer look at both of these significant operations will be part of this panel's program. The solids pipeline, still very much in its youth, has yet to pioneer in the North.

To what extent will solids pipelines and additional railway mileage go on the Northern transportation map in the years ahead? Much of the answer will pivot on physical factors. Definition will have to be made not only of geographic sources and destinations for traffic, anticipated volumes and distances, but also on the nature of the commodities to be moved and the extent and location of processing or preparation of them in the North vs. the "outside". The practical feasibility of transporting the traffic by a given mode will also be critical: for a pipeline, illustratively, can the product be satisfactorily carried in slurry, pellet, slug or encapsulated form? Also, decisions will have to be made on the intended rationale of the particular transportation system, with respect to whether it is going to perform a gathering or "main line" function, whether it is to move a variety of goods or only selected types, whether it is uni- or bi-directional (pipelines can side-step the return of

empty equipment). Finally, will terrain and climate conditions permit the mode's installation and operation? The experience with Northern railroads has provided valuable information as to their capabilities. It is to be hoped that the results of the various oil line test efforts near Inuvik will have applicability as well to solids pipeline research.

Whether solids pipeline and new railway mileage is to be added to the North will rest ultimately, however, on economics. As mentioned earlier, both forms are capital intensive, and impose reasonably stringent minimums on the offsetting traffic levels they require. These tests could as well be met by an aggregate of users and benefits as by utilization for a single purpose. In the broadest sense, their justification may lie in whether a net plus for the economy as a whole will be made possible by the system's existence. Maximizing this return and avoiding mistakes in commitment and timing are paramount in an economy where transport costs are acknowledged to exert major leverage on remote resource development. And expenditures contemplated for Northern transportation must compete with demands and opportunities that arise elsewhere.

Government will continue to be vitally interested in developments concerning railway and solids pipeline possibilities in the North. Their implications for the pace and fulfillment of the overall federal policies and objectives for this region

are recognized to be far-reaching. Moreover, there will be substantial influences on what action is taken on support facilities such as ports and on alternative transportation means. This exhange of views on rail and solids pipline prospects is welcome.

NOTES ON INTERMODAL TRANSPORTATION

BY: MR. A.F. JOPLIN
Director, Development Planning, Canadian Pacific Railways

Although the concepts of intermodal transport are not new, the development of such transportation systems to meet northern applications should be noted. Much pioneer work has been done in the intermodal use of highways, railway and sea transport in the expanding transportation services developed by the White Pass & Yukon Corporation. The institution of this system with appropriate transfer equipment and its operation as a complete system is a remarkable achievement.

In developing northern transportation, not only will new intermodal systems of a similar type be developed, but systems which will combine rail and solids pipelines may also be developed.

Systems Concept in Transportation

In the past fifteen years or so, both business and government have applied the systems approach to their operations. Despite all this development and use, the systems idea, while simple to understand, is uniquely difficult to apply to operations in a specific manner.

The main advantage of the systems approach is to produce true synergism, in which the total effect is greater than the sum of the individual subsystems each taken independently. It is an accepted principle of systems engineering that the individual components are most often sub-optimized in order that the whole project operate as economically and efficiently as possible. There should be as little as possible of one subsystem or another attempting to optimize its own particular link at the expense of the other subsystems and in the end produce a total system less than optimum.

With divergency of authority and agencies, such as is often the case in transportation systems, it is extremely difficult to achieve true systems optimization. One way of overcoming this difficulty is the multi-modal or common ownership which is provided for Canada's transportation legislation. In some respects, the idea of common ownership is sufficient to bring various modes together in a more co-ordinated and co-operative way than might otherwise be the case.

Intermodal Constraints - Pipelines and Railways

The same constraints and special conditions that are associated with each of the modes as outlined in notes for slurry pipelines and railways will have to be accommodated. At the same time, one mode should not be considered as simply a substitute for the other. Intermodal systems using pipelines and rail have some characteristics which should be noted.

a) The economics of slurry pipelines are such that the cost of the processes of reducing the commodity to slurry form and its reconstitution to a dry bulk or equivalent form, although variable to some extent, require transmission by the pipeline mode over a fairly long distance in order to justify the cost of this processing.

b) The operation of a production plant at one location and a reconstitution plant at another location introduces additional considerations in provisions for surge in the system, the location of personnel and the administration of townsites, power plants, etc., that may well offset the advantage of using a pipeline as part of the transporation system.

c) Although the connection to the railway network of continental Canada and United States does place a product or material within the economic market of these two countries, the far wider markets of the world are available to a product or material delivered to tidewater. With slurry shipping in large sea-going vessels now becoming a reality, there may well be reasons to take the slurry by pipeline to water rather than using rail.

d) It is not likely that easy disposal of a hydrocarbon carrier will be offered at the interface of pipeline and wheeled carrier. In all likelihood, the carrier will be water. There may well be economics if the pipeline distance is short enough in recirculating the carrier. Because of water scarcity in the north arid areas, this might well apply even to water.

NOTES ON SLURRY PIPELINES

BY: MR. A.F. JOPLIN
Director, Development Planning, Canadian Pacific Railways

Transportation by pipelines offers systems more capable of automatic unattended operation than any other known system for the movement of solids, liquids or gases. This characteristic has been extensively developed in gas and this same characteristic could be modified for northern development and oil pipeline systems elsewhere in the world.

Two pipeline systems, slurries and capsules, both capable of developing transportation of solid commodities at low ton mile costs have been under intensive investigation for the last fifteen years. Transmission of slurries is not, however, a new technique. Many small systems have been in operation since before the turn of the century. Transmission of commodities in capsule or in slug form is a more recent study which shows considerable promise. In this system, a capsule or formed slug of the commodity moves in a separate medium or carrier liquid. In the slurry system, the material moves as a liquid containing fine materials in suspension.

Transmission of commodities by pipeline in slurry form has occupied a much larger place in the field of transportation research and development than transmission by capsule or slug and is, therefore, further advanced. Development of slurry pipelines, however, requires special conditions.

Slurries and Carrier Liquids

a) Slurries consist of a material which usually exists as a solid suspended in a finely ground state in a carrier liquid. Generally the carrier liquid is water. Alternative carriers such as hydrocarbons can also be used.

b) In addition to the material to be moved, there must also be a source for the carrier element.

c) Where water is used, there must be provision for disposal. The effects of water diversion and water disposal on the environment must be considered.

d) Hydrocarbons when used as a carrier have an economic value. There is seldom, however, such a neat balance in the economy that just the right amount of hydrocarbon is available and can be marketed to balance out the amount of solid material and the markets for it.

Slurry Material

a) The material must be capable of being processed to a very fine state and recovered after transmission for use. The processing in preparation or recovery may often add to the value of the commodity or improve some other phase of its production and/or use. A systems study is required to determine the complete picture and to allocate the burden and advantage on an economic basis.

b) The material must not react with the carrier (or if it does, this must be made part of a production process).

c) Assured reserves of the commodity must be available. Generally this means that large ore bodies capable of sustaining production over a considerable term of years are needed.

d) The commodity must be capable of sustaining itself on competitive world markets.

Physical Constraints

a) Commodity pipelines best serve one origin and one destination point. Some gathering and limited dispersal at destination can be developed, but there is limited flexibility in this regard.

b) Gas pipelines or oil pipelines can generally be linked together to form interconnecting pathways and systems. This same facility is not available to commodity pipelines. Each application must be developed as a special case.

c) Cresting through mountain ranges or high heights of land and crossing through the troughs of valleys add considerably to the engineering of lines due to the much more stringent grade limitation imposed on slurry lines as compared with lines transmitting homogeneous liquids.

d) Specific gravity of slurry materials and operating and static pressures associated with higher specific gravities increase wall thickness of pipe and horsepower requirements over those generally used in oil and gas transmission.

e) The conversion of line from one material to another is not easily achieved. Generally there is inflexibility in this aspect.

Economic Constraints

a) The economics of slurry lines are extremely sensitive to volume. Pipelines should be so developed as to reach maximum operating efficiency early in economic life.

b) Levels of operation involving any large variations in rate of throughput must be avoided if the economics of the line are to remain favourable.

c) Long range market commitments for the product of the line is necessary for financing. Mortgaging of the physical plant is not generally considered to be sufficient security for the debt portion of the financing.

d) Pipeline rights-of-way are generally owned, leased, or held on easement by private industry.

e) Economic sources of power for transmission pumping are vital.

Environmental and Development Factors

a) Slurry pipelines use energy and in transmission this energy is transferred into the surrounding soil mantel. The amounts of heat are generally not significant but must be accounted for.

b) Pipelines do not occupy the surface or create obstructions to free passage.

c) Pipelines are generally considered a closed system and, therefore, the losses from blowing dust, fumes, etc., are not a factor adversely affecting environment.

d) Pipelines do not generally require intensive use of manpower, and their care and operation can be automated to a large extent. They, therefore, do not bring with them the larger numbers of people that are required for other transportation systems.

e) Pipelines operate generally only in one way and are therefore not helpful in the supply of inward transportation for the development.

NOTES ON RAILWAY DEVELOPMENT

BY: MR. A.F. JOPLIN
Director, Development Planning, Canadian Pacific Railway

Railways as a system of transportation can be the most flexible and at the same time more economical of resources than any continental based transportation mode. Although the basic application of the steel wheel on the steel rail and operation over limited gradients is over one hundred and fifty years old on the North American continent, associated developments and improvements in rail techniques have improved more in the last twenty-five years than in the previous one hundred and twenty-five. Unfortunately, the understanding of the contribution to the welfare of the nation that can be made by economical viable rail systems has not found much acceptance with the general public. As a result, the demands made by the public for non-compensatory or marginally profitable services by the railroads limit the ability of the railroads to perform at anywhere near maximum efficiency.

The development of the North or the mid-North will not be best served by the construction of another east-west railway across Canada. This country is already more than adequately provided with east-west rail transportation by its two existing trans-continental systems. These systems are, in turn, linked with perhaps one exception with north reaching systems. The development of northern rail transportation requires careful extensions of these existing systems to meet express needs. New northward reaching systems may be required but these should find their origin and immediate connection in the existing east-west rail lines. The older dicta that "railroads lead to development" and that a country can be opened up by construction of a railroad are not valid in Canada's northern areas. Any program of northward extension of rail should be based upon an economic assessment of development potentials and main connecting routes established to account for these developments on some established time scale.

Railroad development is generally regarded as an engineering undertaking. In the sense that the wider view of engineering is -- "art of doing - well with one dollar, which any bungler can do with two after a fashion"* -- "engineering undertaking" is adequate.

Railroad constructed for "political" reasons or as "visions" or northward development will only saddle the developing economy of

* - A.M. Wellington, "The Economic Theory of Railway Location."

the North with a weight of debt and maintenance expense that will prohibit rather than encourage development. Under such a surcharge it will not be possible for the resources and the products from these resources to compete on the world markets.

The real danger in rail development comes not from those that are obviously uneconomic and are, therefore, abandoned or dismantled, but rather from those developments that are marginal and so require contributions from the well developed and successful operations. This has the effect of dragging down the total operation and producing the malaise of inadequate return on investment. In turn, this hampers development in areas where new works could be successful and restricts the amounts of capital available to improve service where demand may well justify new investment.

Rail transportation must then be set in as complete a matrix of continental development and resource utilization as possible. The following characteristics of rail transportation are those easily identified.

1. Passenger Service

   Although rail has contributed over the years a considerable resource to passenger carrying in the past, the development of the private automobile and bus with the increase in the highway system have removed the passenger who requires transportation for the shorter distances. The speed and convenience of air travel at prices little different from rail have drawn the majority of the longer distance traveller to that mode.

   In the development of the mid-North and farther, where distances between centres of urbanization are even farther apart than much of the developed south, passenger rail trains are not likely to offer a mode of personal transport acceptable to the public or profitable to rail enterprise.

2. High Class Smalls and Less Than Carload Traffic

   The light population concentrations that are to be expected in developing areas is unlikely to furnish the density of traffic needed to sustain rail service as a mode in this field. The provision of limited service during Spring break-up when highway truck operation is restricted could be in some demand. During this period the type of rolling stock that is needed might be borrowed from the major transcontinental systems so as to provide piggyback or trailer-on-flat-car service. Limited development of terminal

facilities to accommodate this service is probably the most that can be economically justified. Over-expansion in this area is a danger that will be difficult to avoid since the public does not understand the costs required to maintain a little used service.

3. <u>General Freight</u>

The development of a general freight service will require a tie-in at many convenient points with the transcontinental systems, if rates that are acceptable for this traffic are to be established. General freight alone during the development periods could not in any way be sufficient to maintain an additional east-west rail line across the country. The competition for this traffic will be the road truck hauler. General freight by truck lines northward will move at least part way across the continent by the more economic main rail systems or on competing trans-Canada trucks.

4. <u>Commodity Freight</u>

The main source of revenue from northern development rail lines must come from carriage of specific products of the area under development to the population centres of North America and to the sea coast for world markets. The transportation systems must be designed with this objective having precedence over all others, even to the extent that the rail systems may make the transportation of inward traffic somewhat inconvenient and/or more expensive. Most certainly "political" considerations as between various provinces, territories and federal states should receive no consideration whatsoever.

5. <u>Physical Constraints</u>

a) Rail technology is so well developed and flexible that the constraints of terrain can be overcome. It is more generally a question of cost to overcome the particular physical difficulties. To secure acceptable grades, existing water courses establish the pattern of development but the rail lines are not tied to development along valley lines.

b) Muskeg, swampy terrain, large temperature variations, snow and other difficulties of construction and operation in the mid-North have already been overcome. While it is necessary to accept constraints to meet these conditions, they are in no way limiting or prohibitive.

c) Spring break-up has less effect on rail operation than upon highways.

d) Even though the basic construction material for railways is the existing soils and gravels of the area, first costs for construction and even for temporary developments are substantial. There are, however, considerable differences in standards and so in the first costs. The setting of standards that differ too widely from what is necessary to carry the traffic and what the traffic can pay for, can place severe handicaps on the development.

6. Environmental and Development Factors

a) Rail lines pass through drainage systems which are diverted or crossed by bridges, trestles and culverts. The alterations to the drainage systems are usually limited.

b) Diesel-electric locomotives, of the type now in general use in Canada, have little if any impact on the countryside. Locomotive whistles and headlights have aroused the anger or curiosity of some of the larger mammals, with some sad results to the large mammals and occasionally to the offending rolling stock.

c) Rail structures occupy the surface and create limited obstructions to free passage.

d) The basic materials of construction are for the most part those existing in the area and as a result the impact on the environment is limited.

e) Rail transportation in open cars can be a source of blowing dust and fumes, etc., which can have an adverse effect on environment.

f) Rail operations require considerable manpower. This places some strain on frontier development in taking up persons who might be engaged in developing resources, but at the same time aids in community development.

7. Financial and Economic Factors

a) Rail lines are two-way carriers and can bring in development goods and supplies as well as carry outward the development products.

b) Railways usually own their own right-of-way which together with the materials, rail construction is pledged to secure in part the debt portion of financing. Land and right-of-way in the northern areas are not particularly valuable and some difficulties in securing debt might be experienced.

c) Rail construction adds value to the land through which it passes beyond the immediate servicing of the facility and traffic for which the line is built. In the past, specified payments in land for construction and subsidies on a mileage basis were used as convenient methods of recognizing this situation and assisted in financing construction. The public attitude towards this method of financing has been considerably eroded over the years and other methods of recognizing the "added value" of railway construction may have to be found.

INTEGRATED TRANSPORTATION IN THE YUKON

BY: MR. R.R. LATIMER
Vice-President, Operations, White Pass and Yukon Route

THIS CONFERENCE HAS BEEN GATHERED TOGETHER TO TALK ABOUT DEVELOPMENT OF TRANSPORTATION AND TRANSPORTATION SYSTEMS IN THE NORTH AND WITH THIS IN MIND, I WANT TO EMPHASIZE THE DEVELOPMENT ASPECTS AND PROBLEMS OF THE YUKON, AND THE WHITE PASS & YUKON ROUTE'S THINKING ON THESE PROBLEMS, RATHER THAN TO GENERATE A DISCUSSION OF THE OPERATIONAL PROBLEMS OF A WORKING RAILROAD IN THIS PART OF THE COUNTRY.

THE WHITE PASS & YUKON ROUTE HAS A LONG HISTORY IN THE NORTH, TRACING ITS ORIGINS BACK TO THE RAILWAY BUILT AT THE TURN OF THE CENTURY BETWEEN SKAGWAY AT THE TOP OF THE ALASKA PANHANDLE AND WHITEHORSE. UNTIL THE EARLY 1950'S THE PATTERN OF THE COMPANY'S OPERATION HAD CHANGED VERY LITTLE OVER THE YEARS, BUT UNDER THE TWIN PRESSURES OF INCREASING COSTS AND THE STIRRING OF YUKON DEVELOPMENT A CRISIS WAS GROWING IN THE TRADITIONAL PATTERN OF OUR OPERATIONS. IT WAS THEN THAT THE BASIC DECISION WAS TAKEN TO INTRODUCE A FORM OF INTEGRATED TRANSPORTATION TO THE YUKON. SINCE THAT DATE, THE COMPANY HAS REFINED AND DEVELOPED SPECIAL CONTAINER SHIPS AND AN INTEGRATED OCEAN-RAIL-HIGHWAY TRANSPORTATION SYSTEM MAKING USE OF SEVERAL DIFFERENT TYPES OF CONTAINERS TO FIT SPECIFIC APPLICATIONS.

OUR LATEST MAJOR STEP FORWARD HAS BEEN THE DESIGN OF A COMPLETELY NEW ORE CONCENTRATE CONTAINER SYSTEM USING A UNIQUE PARABOLIC SHAPE TO ALLOW CLEAN DUMPING OF THE UNIT. BASED ON THIS CONTAINER, AN INTEGRATED TRUCK-RAIL

HAUL OF LEAD AND ZINC CONCENTRATE FROM ANVIL MINE IN THE HEART OF THE YUKON, 340 MILES TO OUR NEW DEEP SEA TERMINAL AT SKAGWAY HAS BEEN OPERATING FOR THE PAST YEAR.

THE DESIGN PROBLEMS OF PRODUCING A LIGHTWEIGHT CONTAINER WHICH WILL DUMP IN ALL WEATHER CONDITIONS AND IS STRUCTURALLY ABLE TO TAKE THE HIGH STRAINS OF MOVING 30 TON PAY LOADS OVER 230 MILES OF YUKON HIGHWAY ARE LEGION. THE BASIC SHAPE OF THE CONTAINER AND THE CURVATURE OF THE CORNERS MUST BE DESIGNED TO MEET DUMPING REQUIREMENTS AND STRAIN. CORNER CONSTRUCTION WHERE MOST OF THE TORSIONAL FORCES IN HIGHWAY TRANSPORT AND IN DUMPING OPERATIONS ARE FELT WAS A PARTICULARLY TRYING EXPERIENCE. THE CONFLICTING REQUIREMENTS OF SAFE LIFTING ON TRANSFER AND EASY ROTATION FOR DUMPING HAD TO BE RESOLVED AS DID THE CONFLICT BETWEEN THE CONTAINER REQUIREMENTS FOR THE STIFFEST POSSIBLE TRAILER AND THE EFFECT AN EXTREMELY STIFF TRAILER HAS ON A TRACTOR UNIT.

THIS IS JUST THE LATEST AND LARGEST INSTANCE OF THE PARTNERSHIP THAT HAS DEVELOPED BETWEEN OUR COMPANY AND THE PRINCIPAL MINING CONCERNS THAT FORM THE YUKON ECONOMY. IT IS A PARTNERSHIP THAT HAS WORKED VERY WELL UP TO THE PRESENT BUT WE ARE ALL AWARE THAT THE EXISTING MINES IN THE TERRITORY HAVE TO COMPETE ON WORLD MARKETS, AND TRANSPORTATION COSTS ARE OF GREAT SIGNIFICANCE TO THE HEALTH OF EXISTING PROPERTIES. OF JUST AS GREAT CONCERN IS THE FACT THAT CANADA'S NORTH MUST COMPETE FOR MINING EXPLORATION WITH OTHER MINERAL AREAS OF THE WORLD AND, WHILE SEVERAL FACTORS ENTER INTO EXPLORATION DECISIONS, AN ADEQUATE AND EFFICIENT TRANSPORTATION SYSTEM WILL PLAY A LARGE PART IN DETERMINING THE EXTENT AND TIMING OF FUTURE DEVELOPMENT IN THE TERRITORY.

WHITE PASS, OF COURSE, IS A COMMERCIAL TRANSPORTATION COMPANY AND ONE THAT HAS HAD MANY YEARS OF MARGINAL OR LOSING OPERATIONS IN ITS PAST HISTORY. ACCORDINGLY, THE PHILOSOPHICAL AND PHYSICAL DEVELOPMENT OF THE PRESENT CONTAINER SYSTEMS HAVE BEEN TEMPERED AND FORMED AT ALL TIMES IN THE LIGHT OF PRACTICAL REALITIES.

SUCH REALITIES WILL BE FAMILIAR TO ALL OF YOU WHO ARE CONCERNED WITH THE OVERALL VIABILITY OF A BUSINESS. PERHAPS MOST COMPELLING IS THE PRESENT INVESTMENT IN USEFUL EQUIPMENT AND FACILITIES WHICH CANNOT BE JUST WRITTEN OFF IN THE INTERESTS OF THE MOST SOPHISTICATED SYSTEM. INSTEAD, EACH CATEGORY OF EQUIPMENT AND EACH FACILITY MUST BE CONSIDERED TO DETERMINE WHETHER IT CAN BE SUCCESSFULLY ACCOMMODATED IN THE TOTAL SYSTEM WITHOUT SACRIFICING THE ESSENTIAL CHARACTERISTICS OF THE SYSTEM. OFTEN ONE FINDS THE ACCOMMODATION CAN BE MADE AND THEN AT A LATER DATE, IF THE OVERALL DESIGN HAS BEEN FLEXIBLE ENOUGH, THE GRADUAL REPLACEMENT OF THOSE PARTS OF THE SYSTEM WHICH WERE RETAINED FROM EARLIER OPERATIONS CAN BE UNDERTAKEN. IN PARTICULAR, SUCH IMPORTANT BUT EXPENSIVE PARTS OF A SYSTEM AS STORAGE AREAS AND DOCK AREAS CAN BE LESS THAN IDEAL WITHOUT ABANDONING THE TOTAL CONCEPT.

IN THE CASE OF WHITE PASS, THE ENTIRE BASIC PACKAGE FREIGHT CONTAINER SYSTEM THAT WE HAVE TODAY WAS BUILT UP PIECE BY PIECE OVER THE YEARS AND AT EACH STEP OF THE WAY, WE WERE FORCED TO ACCOMMODATE MUCH OF THE PAST BECAUSE WE SIMPLY COULD NOT AFFORD TO REPLACE IT ALL AT ONCE. AND THIS PROCESS IS CONTINUING WITH THIS BASIC SYSTEM SO THAT WE STILL HAVE SEVERAL PARTS OF IT WHICH ARE RETAINED FROM THE PRE-CONTAINER ERA.

AS CONTRAST WE HAVE OUR NEW BULK CONTAINER SYSTEM WHICH IS ESSENTIALLY A PARALLEL PROCESS, BUT WITH BRAND NEW DESIGN, NEW EQUIPMENT AND NEW FACILITIES AT EVERY STEP OF THE WAY. HAVING GONE BOTH ROUTES, WE KNOW THAT EACH IS PRACTICAL AND EACH OFFERS CERTAIN ADVANTAGES AND SOME DISADVANTAGES ALONG THE WAY. HOWEVER, I PARTICULARLY WANT TO STRESS THAT THERE IS NO REASON FOR THIS PHILOSOPHY OF CONTAINERS AND INTEGRATION TO BE HELD UP BECAUSE OF LACK OF FUNDS FOR A GRANDIOSE TOTAL SCHEME. IF THE PROBLEM IS ATTACKED WITH ENTHUSIASM, IT CAN BE VERY PRODUCTIVE TO GO AT IT A PIECE AT A TIME.

I MENTIONED THAT THERE ARE ADVANTAGES TO SUCH A COURSE OF ACTION, AND THREE IMPORTANT ONES COME TO MIND. FIRST, IN MANY SITUATIONS IT MAY TURN OUT TO BE THE ONLY PRACTICAL WAY TO GET STARTED. A SCHEME WHICH OFFERS SOME SIGNIFICANT ADVANTAGES CAN BE DEFEATED BY THE INABILITY TO FINANCE IT. SECOND, THE PIECE BY PIECE APPROACH MEANS THAT AS EACH SEGMENT IS ADDED, YOU GAIN BY YOUR OWN EXPERIENCE AND THAT OF THE INDUSTRY SO THAT YOUR FINAL SYSTEM CAN BE CONSIDERABLY MORE EFFECTIVE THAN HAD IT ALL BEEN CONCEIVED AND BUILT AT THE BEGINNING. FINALLY, THE PROBLEM OF TRAINING AND ADAPTING EMPLOYEES IS GREATLY FACILITATED RIGHT THROUGH THE VARIOUS LEVELS FROM MANAGEMENT TO SUPERVISORS TO UNIONS, AND AS MOST OF YOU ARE WELL AWARE, PERSONNEL ADAPTABILITY AND ATTITUDES ARE A PRETTY IMPORTANT KEY TO SUCCESS IN A CONTAINER SYSTEM.

THE CASE FOR THE COMPLETE NEW SYSTEM IS THE REVERSE OF THAT FOR THE PIECE BY PIECE APPROACH. CERTAINLY IT APPEALS TO THE CREATIVE MAN IN EACH OF US TO CONCEIVE AND BRING INTO BEING A TOTALLY NEW SYSTEM,

AND I CAN SPEAK FROM THE EXPERIENCE OF OUR COMPANY THAT IT IS AN ENORMOUSLY SATISFYING EFFORT. IT ALSO HAS THE UNDISPUTED ADVANTAGE THAT EVERYTHING IS PLANNED TO WORK TOGETHER, THAT COMPROMISES ARE REDUCED (BUT NOT OF COURSE ELIMINATED) AND THAT EACH PART OF THE SYSTEM IS GEARED TO ITS NEIGHBOURING PARTS SO THAT THERE ARE NO BOTTLENECKS.

THIS IS ALL TRUE IF ABSOLUTELY EVERYTHING GOES RIGHT, BUT IN FACT, WE ALL KNOW THAT THERE ARE TWO AREAS WHERE THINGS CAN GO WRONG, AND WHEN THEY GO WRONG IN A TOTALLY NEW SYSTEM, THEY ARE REAL ULCER MATERIAL. THE FIRST POTENTIAL FOR TROUBLE IS THAT PERFORMANCE UNDER DAY BY DAY FIELD CONDITIONS CAN QUITE OFTEN BE RADICALLY DIFFERENT FROM EXPERIENCE UNDER TEST CONDITIONS, AND PARTS OF A NEW SYSTEM MAY EITHER FAIL TO PERFORM TOTALLY OR PERFORM FAR BELOW EXPECTATIONS PRODUCING A MAJOR BOTTLENECK. THE SECOND POTENTIAL FOR TROUBLE IS THE ADAPTABILITY OF COMPANY PERSONNEL. I CONTINUE TO BE AMAZED BY THE EFFECTIVENESS OF PRACTICAL OPERATING PEOPLE WITH NEW EQUIPMENT AND NEW IDEAS, BUT WE ALL REALIZE WHEN TOO MUCH THAT IS NEW IS THROWN A WORKING FORCE, THE RESULTS CAN RANGE FROM MILD CONFUSION TO TOTAL CHAOS.

ADVANCE TRAINING HELPS, A GOOD ATTITUDE IS ESSENTIAL, BUT EVEN WITH BOTH THESE, A COMPLETE NEW SYSTEM CAN PRODUCE MOST UNPLEASANT SURPRISES.

IN OUR OWN CASE, THE EXPERIENCE WITH OUR NEW BULK CONTAINER SYSTEM HAS BEEN A HAPPY ONE. THIS CAN BE ATTRIBUTED TO SEVERAL FACTORS. THE EXPERIENCE OF THE PAST FEW YEARS HAS TUNED THE ENTIRE COMPANY PERSONNEL

TO THE REQUIREMENTS OF A SYSTEM OPERATION, THE COMPANY HAS ALSO LEARNED A GREAT DEAL ABOUT WHAT CAN GO WRONG WITH CONTAINER SYSTEMS, SO WE WERE ABLE TO CONCENTRATE DESIGN EXPERIENCE AND TESTING ON PROBLEM AREAS.

SOME OTHER THOUGHTS I WOULD LIKE TO LEAVE WITH YOU TODAY DEAL WITH THE TRUISM OF THE CONTAINER FIELD THAT PRACTICAL INTEGRATION BETWEEN MODES IS THE TOUGHEST HURDLE TO OVERCOME. AGAIN, TO LOOK AT IT IN TERMS OF OUR COMPANY'S ACTUAL EXPERIENCE WILL PERHAPS BE USEFUL AS A FRAMEWORK BECAUSE IN OUR CASE ALMOST ALL OF THE PROBLEMS OF INTEGRATION HAVE BEEN SOLVED BY ONE OWNERSHIP AND CONTROL OF EACH AND EVERY PART OF THE SYSTEM.

THE FIRST PROBLEM IN INTEGRATION IS ONE OF DESIGN. WHAT DIMENSIONS FOR THE UNITS, WHAT STRUCTURAL STRENGTH, AND WHAT CHARACTERISTICS FOR SUCH SERVICES AS HEATING AND COOLING. ALTHOUGH STANDARDS IN THESE AREAS ARE NOW PRETTY GENERALLY REACHING WIDE ACCEPTANCE, FOR MANY YEARS THESE FACTORS CONSTITUTED A MAJOR BLOCK TO THE DEVELOPMENT OF INTEGRATED SYSTEMS. THE ADVANTAGE OF WHITE PASS IN THIS PERIOD HAS BEEN THE FULL CONTROL OF EACH PART OF THE SYSTEM SO THAT THESE DECISIONS COULD BE MADE QUICKLY WITH A VIEW TO THE OVERALL OPERATION OF THE FULL SYSTEM.

THE SECOND GROUP OF PROBLEMS USUALLY FOUND IN INTEGRATION, CONCERN THE FINANCIAL RESPONSIBILITIES AND REWARDS TO THE VARIOUS PARTICIPANTS. QUESTIONS OF RELATIVE CAPITAL INVESTMENTS, OWNERSHIP OF CONTAINERS,

RATE DIVISIONS, CLAIMS HANDLING AND RETURN OF EMPTIES, ALL CAN BECOME CONTENTIOUS PROBLEMS BETWEEN INDEPENDENT PARTICIPANTS IN AN INTEGRATED SYSTEM. AND AGAIN THE ADVANTAGES OF A ONE COMPANY OWNERSHIP OF THE ENTIRE SYSTEM IS OBVIOUS.

FINALLY, WE HAVE THE PROBLEM OF CONTROL OF THE CONTAINERS, AND WE FEEL IT IS A MOST IMPORTANT QUESTION. WHILE THE CONTAINER IS A PIECE OF EQUIPMENT THAT WILL GIVE YEARS OF LOW COST SERVICE IF IT IS PROPERLY HANDLED, IT IS ALSO A LIGHTWEIGHT PIECE OF PRECISION EQUIPMENT OFTEN WITH SOME REMOVABLE OR WORKING PARTS. CONTAINERS WILL NOT STAND UP TO CARELESS AND ROUGH HANDLING. ALSO, CONTAINERS ARE EXPENSIVE, AND THE MOST EFFICIENT SYSTEM WILL CONTROL THE DISPATCH AND DISTRIBUTION OF CONTAINERS VERY CAREFULLY. FINALLY, WITHOUT GREAT CARE BEING EXERCISED, LOOSE PARTS SUCH AS LIDS WILL BECOME SEPARATED AND LOST. BECAUSE OF THESE REASONS AND BECAUSE WE ALREADY HAVE A LARGE DEGREE OF INTEGRATION, WE DO NOT ALLOW CONTAINERS TO PASS OUT OF OUR CONTROL EXCEPT FOR LOADING OR UNLOADING.

THE SET PURPOSE OF THIS CONFERENCE IS TO DISCUSS THE DEVELOPMENT OF NORTHERN TRANSPORTATION OVER THE NEXT TEN YEARS AND IN PARTICULAR, THE PROVISION OF AN EFFICIENT, ECONOMIC AND FLEXIBLE TRANSPORTATION SYSTEM. THE THOUGHTS AND VIEWPOINTS I HAVE JUST EXPRESSED REPRESENT A RECORD OF WHITE PASS OVER THE PAST FEW YEARS IN COPING WITH THE PROBLEMS OF WEATHER, GEOGRAPHY AND ECONOMICS IN NORTHERN TRANSPORTATION. ALTHOUGH THE RAILWAY HAS BEEN A VERY IMPORTANT PART OF THE TOTAL CONCEPT,

THE OVERRIDING FACTORS HAVE BEEN INTEGRATION AND FLEXIBILITY. WHEN THIS IS COUPLED WITH EXPERIENCED AND INNOVATIVE OPERATING PEOPLE, WE BELIEVE THE RESULTS WILL GIVE THE BEST OPPORTUNITIES FOR ECONOMIC DEVELOPMENT OF THE NORTH.

DEVELOPMENT OF TRANSPORTATION IN THE YUKON

BY: MR. M.P. TAYLOR
Manager, Northern Operations,
White Pass and Yukon Route

This conference has gathered together a variety of people who are interested in the development of transportation systems in - and for - the North. With this in mind, I would like to convey some of the major transportation development problems related to the Yukon Territory, and the White Pass & Yukon Route's approach to finding economically acceptable solutions to them.

The White Pass traces its origins back to 1898, when it built a 110-mile railway from Skagway, Alaska, to Whitehorse in the Yukon. Its purpose - to serve the Klondike gold fields - and to establish a basic Yukon transportation facility that would support, and indeed, encourage, future development.

Until the post-war years, the pattern of the company's operations had changed very little. However, in the early fifties, it quickly became obvious to officials of the newly formed White Pass and Yukon Corporation that unless a reliable, low-cost transportation system was created to encourage the development of the Territory, the Yukon's future looked bleak indeed. It was at this time that the basic decision was taken to build an integrated transportation system to serve the Yukon. It would involve ships, trains, and trucks - all keyed to the movement of 7' x 8' x 8' containers.

Since that date, the company has refined and developed special containers and container ships, rail equipment, port facilities, truck fleets, and material handling equipment - all designed to encourage and support the domestic and industrial growth of the Yukon Territory and adjacent areas.

This original Yukon-oriented container system, which included the first vessel in the world to be launched as a container ship, remained in operation until 1965 - when it was completely upgraded. This upgrading included the introduction of new rolling stock; new 25' x 8' x 8' containers capable of carrying twenty-five tons of freight; straddle carriers to handle containers at terminals and transfer points; re-developed port and terminal facilities; and the introduction of the motor vessel FRANK H. BROWN, a sophisticated 6,000-ton container ship - complete with inboard gantry. In 1968 this vessel was joined by a second ship - a virtual duplicate of the BROWN - christened the m.v. KLONDIKE.

Since the early fifties, development has continued - almost without pause.

Let me give you an example: Based on a unique easy dumping container, employing a parabolic shape, we have recently developed and completed an integrated 340-mile truck-rail transportation system to haul lead and zinc concentrates from Anvil Mine in the Yukon to a new White Pass deep-sea bulk terminal at Skagway, Alaska.

Developing this truck-train concentrate container haul is evidence of the creative partnership that has developed between the principal mines concerned and the Yukon's basic transportation system. We have common goals - common concerns. We are all aware that the Yukon's mining industry must compete on world markets, and that low-cost transportation is vital to the industry's health. It is also recognized that the Yukon must compete for mining exploration with other mineral areas of the world. While several factors enter into exploration decisions, we know that an efficient transportation system is one of them - and a principal one at that.

Creating transportation efficiency is a matter of vital concern to all of us here today. It is a costly undertaking and it is not easy. As an example: The design problems related to the development of a light-weight metal concentrate container for the Anvil haul were legion. It was necessary to build a container that would dump in all weather conditions and be structurally capable of taking the high strains of moving 30-ton pay loads over 230 miles of Yukon highway.

The basic container shape and the curvature of the corners were designed to meet unusual dumping requirements and strain. Corner construction, where most of the torsional forces apply in highway transport and terminal dumping operations, was a particularly trying experience. The conflicting requirements of safe lifting at transfer points and easy rotation for dumping at the Skagway terminal had to be resolved as did the conflict between container requirements for the stiffest possible trailer, and the effect this type of trailer would have on the tractor units.

This type of design application , which must be pursued relentlessly and applied to all parts of the system, is time consuming and costly. And during our 72 years in Yukon transportation, we have become fully acquainted with the agony of marginal or losing operations. Accordingly, the philosophical and physical development of our two present container systems has been tempered and formed in the light of practical realities.

Such realities are familiar to all of you who are concerned with operating a transportation business in a frontier area. Often under such circumstances, expansion and development seem almost beyond reach. One cannot simply write off present investments in the interest of developing more sophisticated transportation facilities. Instead, each category of equipment and each facility must be carefully considered, to determine whether or not it can be successfully accommodated in the projected system without sacrificing its essential characteristics. Often one finds that this accommodation can be made. If this happy condition exists and the overall design is flexible enough, it is possible to gradually replace those parts which were retained from the earlier system.

In our case, the entire basic container system, which operates between Vancouver and the Yukon, was built up in stages over the years. At each step of the way, we found it practical to use much of the existing facilities - simply because we could not afford to replace all the equipment and facilities at one time. And this process is continuing. To this day, several parts of our basic container system are hold-overs from our pre-container era.

In contrast to this "piece-at-a-time" process, we developed our new metal concentrate container system from the ground up. It was a brand new design with new equipment and new facilities every step of the way.

So you see, during the course of developing our basic ship-train-truck container system between Vancouver and the Yukon, we built up our facilities in stages over a period of time. However, we developed our parallel container system, which carries Anvil lead and zinc concentrates from the mine to tidewater at Skagway, as a complete project over a relatively brief two-year construction period.

In short - we have done it both ways, and having done so, we know that each way is practical and each offers certain advantages and disadvantages along the way.

When looking at the advantages of the "piece-at-a-time" method, three important ones come to mind. First, in many situations it may be the only practical way to get started. Second, you gain experience as each segment is added. In this way, your final system can be much more effective than if you had conceived and built it all at once. Third, the problem of training and adapting employees is greatly reduced - from management, to supervisors, to unions. Personnel adaptability and attitudes are extremely important to success in operating a container system.

The case for the complete new system is the reverse of that for the "piece-by-piece" approach. Certainly it appeals to the creative man in each of us to conceive and bring into being a totally new concept. Certainly I can speak from personal knowledge that this is an enormously satisfying experience. It also has the undisputed advantage that everything is planned to fit and work together; that compromises are reduced (but not entirely eliminated) and that each part of the system is properly geared to its neighbour.

This is all true if aboslutely everything goes right, but in fact, there are two areas where things can go wrong, and when things go wrong in a totally new transportation system, you have real ulcer material. The first potential for trouble is that performance under day-by-day field conditions can quite often be radically different from experience under test conditions. Parts of a new system may either fail to perform properly or perform far below expectations. The second potential for trouble is the adaptability of company personnel when they are faced with a totally new pattern of operations.

Advance training helps, a good attitude is essential, but even with both these, a complete new system can produce most unpleasant surprises.

In our own case, the experience with our new metal concentrate container system has been a happy one. This can be attributed to several factors, but a major one is that our container experience of the past few years has tuned White Pass people to the requirements of container system operations.

I have two final thoughts I leave with you today. The first is that, in the container field, integration between modes can be one of the most trying hurdles to overcome.

The major problem in integration is one of container and equipment design. What dimensions? What structural strength? What characteristics for such services as container heating and cooling? Although standards in these areas are now generally reaching wide acceptance, for many years these factors constituted a major block to the development of integrated container systems. The White Pass had an advantage here in that the company is in full operational control of each part of the system. Decisions can be made quickly with a view to the overall operation.

The second group of problems usually found in integration, concern the financial responsibilities and rewards to the various participants. Questions of relative capital investments, ownership of containers, rate divisions, claims handling and return of empties, all can become contentious problems between independent participants in an integrated system. Again, the advantages of a one company operation are obvious.

Finally, we have the problem of container control - a most important question. While the container will provide years of low-cost service, it is also light-weight and built with precision - often with removable or working parts. They will not stand up to rough handling. Containers are also expensive, and the most efficient operators will very carefully control container dispatch and distribution.

Now my time is almost up and I close with the thought that this has been a very brief review of White Pass developments over the past few years, touching on some of the problems we faced, and some of the things we learned, as we went about our business developing a fully integrated container system to serve the Yukon and adjacent areas.

The set purpose of this conference is to discuss the development of northern transportation over the next ten years. I hope this very brief review of the White Pass experience in container systems development has been helpful to everyone who is interested in transportation, and its historic contribution to northern progress and growth.

RAILWAY CONSTRUCTION DOWN NORTH

BY: MR. V.R. COX
Saskatchewan Area Manager, Canadian National Railways

The purpose of this paper is to review and elaborate on recent northern railway construction to provide a better understanding of railway location and construction into those areas beyond the present " railway frontiers". These "frontiers" to the Arctic areas can be better visualized with such place names as, Schefferville, Quebec, Churchill and Lynn Lake, Manitoba, Hay River, N.W.T., and Whitehorse, Yukon. Since 1950 Canadian National has been responsible for nearly 2,000 miles of new railway construction, and, if you include all other railways, nearly 3,000 miles of new line has been constructed. The majority was constructed into the north, for the prime purpose of providing that mode of low cost mass transportation necessary for the exploitation of base metals in vast annual tonnages. Secondly, to service the related communities and the industry frequently generated in a broad band along the routes. Conventional thinking has envisaged lines generally extending northerly to service needs as they have been progressively justified.

It is not the intention of this paper to discuss that broad and varied subject of justification of new northern railways, whether by economic, sociologic, or other evaluation.

A question often asked is, "what is so different about Railway building from highway building -- the quick answer is two steel rails four feet eight and a half inches apart, attached to 8 foot cross ties, compared to a highway some 50 feet in top width. In actual fact, the physical construction of the railway subgrade, drainage system and bridges, is basically the same as constructing a highway. Dimensions are somewhat different but the specifications and procedures for construction are similar. Laying rail and surfacing track with ballast is obviously different. The major difference is in the determination of the location. Both have the common objective of obtaining a route, the shortest distance between origin and destination, but the railway to be economically functional, requires the absolute minimum gradient (rate of climb) that can be achieved in relation to distance, summits, rate of curvature; capital, maintenance and operating costs. Unless country is level, which is rarely the case, the most exacting judgement in selecting the route and care of detail in determining the best location is of paramount importance. This location phase, even with the aid of modern photogrammetrically prepared detailed maps, tends to be more of an art than a science. By example, the Great Slave Lake railway, 432 miles in length, was located to provide a railway having maximum grades in both directions, no greater than 0.6%, a rise of only 30 feet in any mile. This resulted in a train of 12,000 gross tons being pulled by

diesel units totalling only 10,000 horsepower. By comparison the adjacent MacKenzie Highway built to a good standard, has maximum grades in the vicinity of 6%, or a permissible rise of some 300 feet in a mile. A modern tandem highway truck pulls some 37 gross tons with about 250 h.p. A recent railway in the mountains has been located and constructed so that one grade climbs continuously for 30 miles.

"Arctic Transportation Problem Critical" was a lead article in the transportation section of the Financial Post, November 7, 1970. A concise review of the various proposed modes of northern transportation was made. Respecting railways, the article stated "Railway transportation is unlikely to be expanded in the Arctic because of the problems involved in laying track on permafrost and other unstable terrain".

Railway construction on permafrost is not new, the northerly 125 miles of the Hudson Bay Railway to Churchill was built in the main on permafrost. The benefits of being built on what in effect is concrete are still being appreciated 40 years later. This portion of that railway has required the lowest level of maintenance, yet provided some of the best track on the system. Differential settlement and winter heaving of the roadbed common to railways in northern climates is virtually non-existent; some original untreated wooden ties still remain in the track due to the extreme slow rate of decay.

Southerly for some 200 miles through a transition zone of sporadic permafrost, is a different matter, obstacles to construction and operation occur, but certainly not in proportions to obviate a railway. Permafrost is better known for its serious foundation problems related to heat transfer such as from buildings and pipelines. Neither permafrost nor unstable terrain have prevented railways in the past, nor will they in the future in advancing down north. Experience has shown by employment of ingenuity and proper construction techniques permafrost can be an asset to a railway.

Railway construction costs are frequently requested on an average per mile basis. Due to the numerous and varied factors they cannot be generalized. For example, the Great Slave Lake Railway, 432 miles in length, required some 17 million cubic yards of materials to be moved; the Alberta Resources Railway, through the foothills and the mountains, was only 235 miles long but required movement of some 45 million cubic yards of varied materials.

In respect of future railways beyond the present railway frontiers, there is little doubt costs will be high, normal work seasons are shorter. Also, the ability to do "off season" winter railway construction work recently established to be practical, is so, only to about -20°. The periods available to this winter work method can be expected to be shorter, but there is no question it can be done.

In Western Canada our most northerly rail-head terminates at Hay River, N.W.T., north of latitude 61°. By contrast, the USSR has in excess of 3,000 miles of interior railway north of latitude 60° and in excess of 500 north of latitude 66°, within the Arctic Circle. Projections of more to be built are known.

CN has developed considerable new technology to effect the rapid building of railways into the north, and at the same time is well aware that physical obstacles will present themselves as railways advance into the Arctic beyond the present 'frontiers'. The vast areas lying down north, as in the past, present real challenges to obtain economic transportation. We are confident these challenges will be met.

In case you consider I am overzealous on behalf of railway transportation, let me say that no train can match the cost performance of a ship, the convenience of an automobile, the flexibility of a truck, the speed of an aircraft, or the automation of a pipeline. Technology to date has not established any proven alternate, economic or otherwise, by ship or by pipe, to a trunk railway to assist the exploitation of base metals and other resources known to be abundant in our north, and move these mass tonnages long distances to smelter or markets.

Finally, to satisfy the ecological demands that are believed required, the cellular method of the rail transportation mode, along with its capability to carry virtually any type of traffic, will come more to the fore than has previously been considered.

VOLUME 3

SECTION 4 - MARITIME BULK SHIPPING AND ICEBREAKER SUPPORT

CHAIRMAN: A. Pullin

PANELISTS: J. D. Leitch

J. G. German

D. M. Ripley

"A ship may be beneficially owned in one country, directly owned by a company resident in another country, registered under the flag of a third country and accordingly subject to its rules, managed by a company in a fourth country, be on long term charter to interests in a fifth country, and even sub-chartered to interests in yet another country".

Rochdale Report.

ARCTIC BULK SHIPPING

BY: MR. J. D. LEITCH
President, Upper Lakes Shipping Ltd.

Paper to be delivered by Mr. J.D. Leitch, President, Upper Lakes Shipping Ltd.

Although this is an Arctic Transportation Conference, this session is on the subject of "Maritime Bulk Shipping and Icebreaker Support". I speak today as one who has had experience in bulk shipping for a number of years, which, although it has been primarily restricted to the Great Lakes-St. Lawrence System, includes some specialized ocean activities with Canadian ships!

My experience with problems in ice has been passive, and so far most Canadian shipowners have not seen the problem attacked and conquered, but have submitted to the elements by closing their operations for the winter. I intend, therefore, to refer to the problems facing Canadians who might wish to become involved in the Arctic on a competitive basis in international bulk shipping, and propose several methods which may assist our shipping industry to reach this objective.

Numerous studies have been made of the prospects for the movement of bulk raw materials from the Arctic to world markets. These prospective markets are not limited to Canada, or even to North America, but would include Northern Europe and Japan, and perhaps even China.

The reserves which are indicated include oil, gas, iron ore, lead, zinc, nickel, copper and sulphur. To the extent that markets exist for these products in North America, they have the option to move by rail, pipeline, unit train or ship--outside of North America they must move by ship, and this may be either direct or in two stages via a stockpile.

Present indications are that when raw materials and oil and gas start moving from the Arctic, there will be a huge demand for large ships capable of trading in this area. These must be new ships, as few if any suitable vessels now exist, and my position today is that Canadian shipping companies can and should take an active part in this shipping operation when it develops.

To suggest that Canadians should take part in opening an Arctic bulk transportation system is a more radical proposition than it may seem at first glance. Canada, for instance, carries almost none of its own grain to foreign markets, or for that matter, any of its raw materials with the exception of iron ore, which is moved from Labrador into the Great Lakes primarily in land-locked Great Lakes ships. Canadians therefore have no ocean bulk fleet. Under present conditions there is no way any responsible Canadian shipowner could seriously hope to compete internationally with large ocean going bulk carriers. The Arctic is presently closed to him.

At the same time I am convinced that to take part in such an operation would be not only an exciting and romantic venture, but that with a reasonable degree of government support and with industry and government co-operation and mutual understanding, Canadians could exercise a dominating position in carriage of bulk materials from the Arctic.

At the present time numerous studies of the Arctic are taking place, exploration and development are proceeding at a rapidly accelerating pace, and as far as bulk transportation is concerned, weather, ice, currents, harbour facilities and related problems are being studied and plans are being developed by government bodies and other concerned groups to press on into the Arctic as soon as buyers and sellers can reach agreement.

Where then do Canadians fit into the picture? Although we claim it is our Arctic, many of the owners and most of the buyers of these materials will not be Canadians. However, in order to get to market, the carriers whether pipeline, rail or ship, will have to spend much time in Canadian territory, will expect assistance from Canadian Government bodies for navigation and ice breaking, and in the case of an accident may pollute Canadian waters or real estate.

It seems to me that there is one area remaining where Canadians can dominate, and that is in moving these bulk materials from the Arctic in our ships--Canadian ships, manned by Canadians,

owned by Canadians, and perhaps in some cases even built by Canadians.

In Arctic bulk shipping we have a clear field--few, if any, suitable ships exist, and we find ourselves in the enviable position of potentially not only being players in the game, but also being able to lay out the ground rules and be referees as well--a bit like the relationship of the New York Yacht Club to the Americas Cup Races.

At this point we have assumed the Arctic will in fact open up for the exploitation of its raw materials, and that the economies of the venture will justify the movement in very large bulk carriers. We must also assume that our goal is to develop Arctic bulk shipping as one which is predominantly Canadian. This would mean that ultimately Canadians should plan on being the world's outstanding specialists on Arctic transportation conditions, and that their ships should be competitive and of high quality, and their crews should be able and reliable. We must therefore plan on being at least equal to the best the world has to offer on the usual aspects of the operation of bulk ships, and better than the rest of the world when operating in ice.

A study is presently taking place under the auspices of the Canadian Transport Commission which will report to the Government on the need for a Canadian-flag deep sea merchant fleet and how such a fleet could operate in competition with vessels of

other nationalities. Certainly the Commission must take into account in its report a number of economic and political factors peculiar to this country, quite apart from the potential benefits to our economy in such areas as balance of payments problems, employment for Canadian seamen and the stimulus that a Canadian deep sea fleet would give to related industries in the marine field.

Primary problems holding back the development of a Canadian deep sea fleet are the capital cost of ships, and the operating costs once the ship is in commission. I believe that these, and all related problems can be overcome if we will attack the problem on a Government-Industry-Labour basis, forgetting old sacred cows and petty prejudices, and working together to provide the best service anyone in the world can give.

In most countries governments do work closely with their shipping industries to encourage them to be competitive. The United States, for instance, has undertaken staggering commitments to produce 300 ships over the next ten years. Many of these ships will be bulk carriers, for which the government will pay a substantial subsidy both for construction and operating. In addition, there will be tax concessions and cargo preferences and other forms of encouragement including financing arrangements. Every shipbuilding country in the world makes financing available up to 80 per cent, and until recently this financing combined

with the British Investment Grant allowed certain owners to build ships with no down payment at all.

It seems to me that the Canadian Government is reluctant to take the Canadian shipowner as a partner to assist in establishing a Canadian shipping industry, and there is some suggestion that the only time reference is made to Canadian shipping is when antipollution regulations are being passed, or when consideration is being given to increasing toll costs or other burdens which the industry is expected to bear.

There are many who feel that Canada is really a railway nation, and it is also quite possible that neither shipowners nor Government officials have made much attempt to narrow the gap that exists between them. There is no doubt, however, that Canadian ships will not trade in the Arctic as long as this gap exists, but if we really wish to work together there are excellent examples of the exciting results of co-operation from almost every other shipping country in the world. If we are successful in closing ranks and co-operating on this project, it should be possible to develop a positive approach to establishing Canadian shipping in the Arctic.

Some of the following problems are traditional, but the suggested solutions which may appear radical to Canadians, would be considered traditional and in one form or another the principles are accepted in most maritime countries:

1. <u>Cost of the ship</u> - At the present time I believe it is impossible to build a ship larger than about 110,000 dwt. in Canada, yet it is likely that water-borne oil and bulk cargoes in the Arctic will move in ships of 100,000 dwt. up to 200,000 or 300,000 dwt. In any event, I would propose that the Arctic should be considered a completely new area of operations, one in which new rules should exist regardless of the size of the ship.

   Could Canada not therefore set up the Arctic as a special zone in which Canadian ships with certain characteristics might operate? Could not the solution to the cost problem of Arctic ships be reached by allowing any Canadian-owned ship trading in and out of the Arctic to enter Canadian registry and trade between Canadian deep sea ports without payment of duty? This would make the cost of a Canadian ship competitive with any in the world. If the Government should wish that certain vessels for this trade should be built in Canada, they might establish an offsetting Canadian construction subsidy and equivalent financing arrangements.

2. <u>Operating costs</u> - The greatest differential of Canadian operating costs over that of countries other than the U.S.A. is in labour costs. Here again the co-operation of management, labour and government is necessary. On management's part the ship must be constructed to operate with utmost efficiency.

Labour unions must agree with the objective of running Canadian ships into the Arctic, and should co-operate to find a means of avoiding stoppages to give continuous and steady operations similar to conditions experienced by foreign owners. Also labour must agree to produce only productive labour without featherbedding for the life of the ships-- such an arrangement is certainly possible, and without long term guaranteed stability this venture could not proceed. One must acknowledge however that Canadian rates of pay for seamen, although lower than U.S. rates, are likely to be higher than those of other countries for many years.

Rates of pay on U.S. ships, however, are subsidized, so relative to all other ships of the world, Canadian crew costs are a greater charge to the shipowner than are those of any other country in the world, and here again Canadians in the Arctic need the assistance of their Government.

The insurance cost of a $20,000,000 ship trading into the Arctic is astronomical. The additional operating charges of a Canadian ship exclusive of insurance, over competitive foreign carriers would be only a fraction of the insurance cost.

The Canadian Government's job is to make the Arctic safe for navigation--why could it not confirm its confidence in its ability to reach this objective? This could be done by the Government's agreeing to underwrite the insurance on Canadian

ships in the Arctic up to an amount sufficient to offset the operating differential.

So now we have equalized capital costs and operating costs, perhaps it is time to attack another sacred cow.

3. Reciprocity with U.S.A. into Arctic - Could we not now look at an approach which might reduce the cost of moving some of these products? I would suggest we consider joint development of the transportation end of this venture by agreeing to suspend the coasting laws for Canada and U.S.A. on the movements of bulk materials out of the Arctic. This would result in the most efficient use of the combined fleets of ships which are more costly than any bulk carriers in existence. The possibility of such a move should be investigated in the near future before large commitments are made--at the moment no one has a significant stake in Arctic bulk transportation, and a development of this sort would be an exciting and unique form of co-operation, surely a principle which has already been successful in the case of the automobile agreement and other acts of reciprocity.

Of course, not all bulk carriers will be for the purpose of carrying huge cargoes of oil or iron ore. Smaller carriers with different characteristics will have to be able to move through ice to move nickel, copper, lead, zinc, asbestos and other products. Although many of these smaller ships could be

built in Canada, experience has shown that Canadian ships can only hope to compete in the international shipping industry if their costs are equalized with those of their competitors. For this reason, the equalization of building and operating costs is essential, and whether or not ships are built in Canada should be secondary, and subject to Government assistance to produce a competitive unit.

There is no doubt that in the near future a steadily increasing demand for the products of the North will develop, if only because the last great source of undeveloped and even unknown mineral deposits lies in the Canadian Arctic.

Bulk transportation in the Arctic is a vital part of Arctic development, but it is only a part of the jigsaw puzzle, to fit in when reserves and markets justify the movement. There is no doubt these moves will take place, and as no fundamental economic laws appear to stand in our way, I hope we can be ready and able to capitalize on this exciting new opportunity.

BULK SHIPPING AND ICEBREAKER SUPPORT IN THE ARCTIC

BY: MR. G.J. GERMAN
Partner, German & Milne, Transportation
Consultants and Naval Architects

The speed with which developments in the North have occurred during recent years, especially in the past year since the first North voyage of S.S. "MANHATTAN", has left many of us with a feeling of wonderment. We cannot see all of the forest for the trees. So much has been discovered by so many in so vast an area with so many problems, and so many ghosts still to be laid to rest.

Not three years ago, many who had spent a lifetime in the business of shipping into northern coastal and Arctic waters felt that the service is a seasonal affair, a short season at that. There was no way, it was contended, that surface ships would ever make a practice of navigating Arctic waters on a regular year-round commercial basis. Not all shipping people accustomed to the rigorous life of the North felt that way, but many did. Probably more so than the uninitiated from the south who had no real knowledge of the conditions to be encountered.

Even more of a dream than the year-round surface ship, seemed the submarine - strictly a naval warfare vehicle. Far too expensive, although from experience of NAUTILUS, SEADRAGON, SKATE and other nuclear subs, it was admitted that subsurface transit was possible under the ice cap, but certainly not as a commercially viable service, governed as commercial operations are, by economics over and above plain technical feasibility.

Then again, who of sober mind would have considered using tug/barge combinations on a regular basis into ice canopied waters? Even during the summer season the Underwriters were unhappy, though aware that with experienced ice masters, ice damage can be avoided in areas along the North Slope or into Hudson's Bay or even farther North.

That was the attitude three years ago.

Beyond the summer melt season of from two to three months, little was known about the ice concentrations and movements. Less was known about the ice thicknesses, ridge counts, ridge structure, or sea ice strength in the full scale regime. It was certainly realized that the ice fields were often under great pressure, primarily from wind action, enough to buckle up great ridges of broken ice which, it was thought, froze together into a solid mass of prodigious strength. No one knew what that pressure was, either as an average or the maximum. It was thought that the ice ridges, the "wrinkles" caused by compression in the sheet, are sometimes pushed up to twenty-five feet in height and that they extend down into the water about six times as deep as their height. Ridges as deep as 150 feet below the surface have been reported. It was thought that the ridge pieces may be frozen solid together both below the surface and above it.

The conspicuous lack of accurate knowledge about the full scale sea ice properties, extent and behaviour, was matched by the equally conspicuous lack of detailed knowledge of the topography under the water. Charted areas were scarce, mainly in local areas where summer re-supply operations, or where some of the modern transits by Labrador or the nuclear subs had taken place. Great expanses of water in the Northwest Passage and between the Parry Islands and in the Beaufort Sea areas remained uncharted. Not a good prospect for setting up commercial shipping operations.

Then again there was the question of the effect of major shipping operations upon the Arctic marine and general ecology. The problems of oil spills, interference with indigenous over-ice routes from the shipping channels cut in the ice cover, the social problems of setting up large operations in a region up to the present the vast and quiet domain of the Eskimos, the preservation of life in a region sparsely populated and supporting life on a slender thread.

Lastly, who had Sovereignty over the Arctic waters? Whose responsibility the matter of charting, navigation aids,

icebreaker assistance, pollution control, and ecology in the waters surrounding the Archipelago?

How could heavy marine transportation for the resource development and extraction industry move commercially into an area so full of hardship and so ill-defined?

It was realized the, no less today, that transportation and the economic solution of the immense problems of transporting the huge quantities of natural ores, oils and gas, would be paramount to development.

Today --- about three years later --- we are much farther along the path to solving most of the problems than many people realize. It has principally been a problem of getting the data. Reliable data with numbers. Data on which the Engineers and Scientists of various disciplines could base realistic estimates of the design and construction requirements of the systems needed to operate in the region. This sort of data has now been gained in considerable quantities and economic estimates and ecological analyses made as a result. Much of the data so far accumulated has not reached all of the interested parties and project studies have been hindered to some extent by the simple problem of making the mountains of information available to all in more or less boiled down form.

The answers are gradually taking on form. The outlines sharpening up as the problems are brought into focus. They are not necessarily easy answers. They are almost all expensive answers. Many will not come into sharp focus without more basic information, but many have reached the point where feasibilities have been established and possibilities more or less determined. The question of cost remains, in many cases, ill-defined. Estimates for large projects are often too low at the start and the prudent planner has learned to expect some increase as details of the projects are worked out. But project estimates in the Arctic regime are far more tenuous --- the Pipelines come to mind at this point --- and it cannot be said that engineering in the

Arctic regime has become an exact science yet. To be fair to the Pipeliners, it should be added that the estimates for the cost of Arctic super-bulkships have also gone up substantially from the expectations of twelve to twenty-four months ago.

In discussing my topic for this address --- Arctic Bulk Shipping and Icebreaker Support --- I realize the many shades of interest in the group before me and I am quite certain things may have been discovered, not yet published, which may reduce to ashes some of the opinions I shall offer. But that is the purpose of this Conference - to debate by address and by panel discussions the many points of view.

This Conference has been carefully organized to cover a great many aspects connected with Arctic maritime transportation and others will be discussing matters such as Aids to Navigation, Terminals, Resources, Hydrography and Geography. This leaves for me --- as I see it --- the heart of the subject of sea transportation. What about the ships? Can they operate successfully? And where? What will be the function of icebreaker support and what sort of ship will be needed for this support? I hope I can shed some light on these questions, for I am a true believer in the ultimate practicality of sea transportation in the Arctic waters regions.

The broad area covered by the single term ARCTIC must, for consideration of sea transport, be broken up into the individual routes to be considered. Clearly, a ship designed for service into sub-Arctic areas such as Hudson's Bay or Foxe Basin will be less expensive or powerful than one built for the same service to Axel Heiberg. This seems quite obvious, but there is a tendency to speak of the requirements for an Arctic merchant ship as being fixed. The ship serving Hudson's Bay area through Hudson Straits from the Southern part of Baffin Bay and points south, will have to deal with one-year ice up to about five feet thickness and pack ice in Baffin Bay up to about six feet with pressure ridging and hummocks up to 20 to 25 ft. depth. The problem of operating to Axel Heiberg involves first year ice up to about seven feet thick and pack up to approximately ten, with up to 60 percent

old ice, heavy ridges and hummocks. Operation through Lancaster Sound will require capability of handling first year ice up to about six feet. East of Resolute conditions are less difficult than West of Resolute, where up to 40 percent old Arctic ice from McLure Strait and the Parry Island Channels fills the passage. (See Figure 2).

When one speaks of a large commercial shipping operation, one usually means a year-round operation. It is true that in some cases ores can be stockpiled, but stockpiling is expensive too. Furthermore, to surge the volume in a short season needed to remove the production of a large annual throughput, presents problems at the receiving end and stockpiling costs are thereby increased.

The loading and unloading facilities at each end must also be increased in capacity to handle what amounts to a short term high capacity operation in handling a year's production in a few months. Scheduling problems with the ships must also be worked out, for they must be kept working if costs are to be less than prohibitive. This means off-season hauling contracts, which in many cases may be difficult to arrange. With the present market for tankers it would be expected that tankers will be an exception to this situation for a time.

Regular year-round operation in the Arctic means high cost ships. Ships that to date have never been built or operated; designed for service in ice cover ranging in average thickness from five feet to ten in most Arctic areas at maximum growth. The attached diagram (Figure 4) shows the approximate range of powers needed to handle these thicknesses for a bulkship of icebreaking hull form, but of more or less conventional proportions. It is easy to see that ice cover in excess of eight feet leads to propulsion systems requirements of possibly impractical size. In such areas, submarine bulkships may become competitive to the surface ship. Thus, for the possibility of voyages into the high Arctic (North of Melville Island) the "supersub" may prove the better choice from the standpoint of economics. This would, of course,

include the possibility of voyages across the pole to Europe, or to Iceland where a transshipment port might be established for transfer to conventional surface tankers. Studies have been carried out which show, furthermore, possible routing of the "supersub" through the Northwest Passage, either to a point on the West Coast of Greenland, probably Gothab, or to Trinity Bay on the North Coast of Newfoundland, for transfer to the more conventional large surface tankers.

In such a service the "supersub" must compete with the surface bulkship in an environment which the surface vessel can handle. Especially on routes which lie in the Eastern Arctic regions south of Ellesmere Island, many miles are under conditions where the drifting of vast fields of pack ice and consequent field pressure are not likely, due to the limited fetch, to close up the channels cut by ships plying through every few days. The ships would, in this area, be capable of moving through heavy winter ice in any case, but progress on average would be considerably hastened by the frequent opportunities to use channels cut only days earlier with only nominal new ice growth.

The recent reported decision of Humble to go with the Alaska Pipeline although pronouncing the surface solution both to the East and to the West of Prudhoe Bay as feasible, should be regarded only in the context of moving oil from Prudhoe Bay. Doubtless many factors entered into this decision, including the proximity of the TAPS pipeline to that location, the desire to start moving the oil to market as soon as possible, domestic market conditions, uncertainty about pending Regulations, etc. The writer can only speculate on the various factors. It is of course regrettable that the findings of the immensely factual and unique data accumulated by Humble will probably not be available for some time to come. Nevertheless a considerable number of studies have been carried out, including instrumented ice trials programs from which very good data has been obtained, enabling realistic estimates to be made of ship parametric requirements and cost estimates.

No matter what the means of transportation for large deadweights out of the Arctic, it will be expensive. High throughputs will be needed in order to obtain economies of scale. Large transportation media, whether ship, sub, or pipe, will be of unprecedented large size and high cost. Wellhead costs, material handling costs and mine head costs must be comparatively low if the product is to reach market at competitive prices. The economic constraint thus placed on the practical removal of raw products becomes more severe as we move farther north and we can expect that a mining or oil supply of economic interest, say, in the Hudson's Bay region, might be totally devoid of real interest at present if it were located in the region of Ellesmere Island or Axel Heiberg. It follows that Humble's decision should not be taken as applicable to shipping from other Arctic source points to other destinations. The announced position of Humble seems careful to state the use of the Northwest Passage on a twelve month basis is technically feasible and has been shelved in favour of Pipeline only on a marginal economic basis. It should not be overlooked that this decision probably applies only to the North Slope oil. The movements of oil or ores from the Islands and offshore areas undoubtedly have a different set of economic factors, any or all of which may favour the marine vehicle solution. Certainly pipeline alternative for transport from the Islands appears to be out because of the great depths of water and the scouring action of grounding ice.

Traditionally, in the open water areas of the world, the most economical way to carry large quantities of bulk ore or oil --- by a wide margin --- has been large surface vessels. These have grown in size by a factor of ten over the past fifteen years. Numerically they are rapidly increasing (Figure 3) and form a substantial part of the world fleet.

Vessels of up to 477,000 tons deadweight size are on order and up to 550,000 are believed pending, although there is increasing belief in many quarters that the "popular" size will be "small", say only 250,000 tons. Studies and Rules have been developed for vessels up to 1,000,000 tons deadweight and it is understood plans have been prepared for

a dock capable of taking a 1,000,000 ton tanker. Manned by small crews (38-45) and powered by relatively small power plants (35,000 HP for a 300,000 ton vessel) these carriers are tremendously economical and manage to move oil at approximately .08¢/ton/mile. Compared to these figures it is estimated:

By nuclear submarine (170,000 ton capacity) - .23¢/ton/mile

By icebreaking supertanker - 0.15¢/ton/mile

It is practically useless to attempt to compare unit costs per ton/mile of the various transportation options in a generalized manner. Each proposed route and commodity is a unique case with its own particular set of conditions. Judgements concerning the cost of insurance, the annual costs of repair and maintenance, fuel, write-off period, interest and the applicable cost of marine terminals, will vary considerably from sub to surface ship, from route to route and from Company policy to Company policy. All possible major modes of transport in the Arctic region have their own question marks opposite engineering problems yet to be encountered, problems not yet fully solved, regulations not yet fully defined, environmental data not yet complete, etc.

However, basing the unit cost per ton of cargo upon the capital invested at normal depreciation, current interest rates and expected insurance rates (very high at first), with educated guesses at the annual costs of repair and maintenance, it is apparent that the surface tanker or bulk ship will probably offer the most favourable returns wherever it may within reason be operated. Although most published estimates to date do give the edge to the surface bulkship, it must, in our opinion, be a case for study for any particular operation, the most suitable system depending upon many factors, such as the kind of produce (subs not ideal for ores), water depth and navigation hazards.

The open water surface vessel of 250,000 t.d.w. can be purchased in foreign yards, such as Japan, for about $25,000,000. In the U.S., extrapolating present building

costs and assuming facilities are constructed for building such large ships, the gross cost would probably be much more, about $45,000,000. For the icebreaking version suitable for all year service as far North as the Parry Channel, the cost increases by about 60%. For year round service into a slightly less difficult region South, say into Foxe Basin or Hudson Bay, the increment is more like 40%.

North of the Parry Channel in the Western Arctic, the case for the conventionally proportioned icebreaking surface ship weakens, perhaps even to the point of impracticality. We are looking at conditions requiring power in the order of 300,000 horsepower for such a vessel which must at least be 250,000 t.d.w. to have both the bulk and thrust needed for steady progress through pack ice and through heavy rafting and ridges. Here one may be inclined to discard the conventionally proportioned surface ship concept in favour of more unconventional concepts, or in favour of the sub. It will be a matter for further research and development to determine how far departures from standard proportions can practically be made. It is our opinion, however, that certain developments in the hull configuration will lead to reduction in icebreaking power requirements by as much as 50%.

The ability of the surface ship to break through the ice cover, whether she is an "icebreaker" or a cargo vessel (assuming she has been adequately strengthened) is dependent upon three principal parameters. These are the power, breadth and weight. Variations in capability can also be obtained by altering the hull design, shape of stem, perhaps even the method of icebreaking, viz. upward breaking versus downward breaking.

Most of you will have noted the spate of interest over the past several years in several revisions to the shape of icebreaking bow forms, the proponents of each claiming improved performance. One of the best known of these improvements, which has received quite substantial publicity, is an upward breaking bow form widely known as ALEXBOW. (Figure 5). The best known improvement to the conventional

downward breaking bow form is known variously as the M.I.T. bow or the WHITE bow, (Figure 6) after its inventor. I do not propose to enter into a detailed discussion of the pros and cons of the two in this address, as the subject is broad in itself. It is worth mentioning, however, that a variation of Alexbow (Alexbow Hammerhead) has certain inherent qualities that are particularly advantageous to the bulk carrier hull form, such as its tendency to leave a clear ice track, reducing the entrainment of ice into the screws or into the path of a following ship. This is a bow form which is integral with the hull, not an attachment. It is not necessarily better than the WHITE bow form in terms of sheer icebreaking ability, but has other performance qualities that warrant thorough investigation when the time comes to prepare designs for the "big ones". The WHITE bow has had extensive testing and, of course, the impressive full scale test it underwent as the bow of the "MANHATTAN" has proved to be a definite improvement over the older style "conventional" bow common to icebreakers up to that time. The ALEXBOW on the other hand has not had sufficient testing to prove or disprove its merit. A number of partial tests have indeed been carried out. Many were, unfortunately, indeterminate, due to incomplete testing conditions or measurements. At least some of the tests have indicated the design to have considerable merit. It should not be abandoned because of an unfortunate history to date of indecisive or incomplete tests. That could very well result in the burying of a design feature capable of enabling the large ship to operate at a significant reduction of overall cost.

For the commercial ship it is not economically practical to build a small strong hull and fill it with power to produce an "icebreaker". A bulk carrier must of economic necessity be large and heavy with minimum expenditure on power, fuel and other expensive things. Thus the icebreaking requirement calling for high power is offset to some extent by the extra icebreaking resistance called for by the greater breadth associated with the larger bulk carrier. Primarily the power level built into such a ship and its minimum weight will depend upon the particular routes in the Arctic she is scheduled to operate. The more northerly and subject to

massive hummocks, rafted ice and ridges, the more massive will be the ship. The more massive hull will help to pass through heavy ridges and hummocks without stopping the ship. Bringing the ship to a full stop will prove uneconomic. It would do for an icebreaker, but not a commercial bulk carrier. Once such a vessel is forced to resort to stopping, backing and ramming, her average daily mileage drops precipitously. A ship moving steadily at six knots through heavy ice can expect to move about 144 miles per twenty-four hour period, or about seven days for 1,000 miles if the going is rough. If she must ram her way, stopping and charging once for each mile, her average speed drops to less than one knot with a daily achievement of some 20 miles. On this basis the 1,000 mile leg requires some 50 days and it is obvious the economics will be blown sky high. For this reason the large bulkship must have sufficient power and suitable hull design to achieve a steady speed through the ice expected. Furthermore, an average speed of from 6 to 8 knots for these parts of the voyage will doubtless be needed to ensure economic viability. Where heavy rafting, ridging or large hummocks can be avoided, the power requirement will depend upon the mean thickness. Where they cannot be avoided over most of the proposed route, the weight must be sufficient to ensure adequate inertial thrust to pass through the largest without having to ram. As an example of this, it may be noted that a 250,000 ton vessel striking a ridge at 8 knots and with full propeller thrust has enough energy to pass through a single ridge of 100 feet draft and 100 feet across without actually stopping. A 150,000 ton vessel with the same power would be brought to a halt and would have to ram her way through with precious loss of time.

The significance of the effect on voyage time of stopping periodically to ram through the heavier ice ridges perhaps is more graphically illustrated by choosing an example where the vessel maintains progress through the ice field at a steady eight knots, except once every twenty miles when she is brought to a standstill. Each time this happens she is able to regain her progress at eight knots for another twenty miles, after backing off and making only one charge at the ice ridge. Such an operation, admittedly hypothetical, will

increase her voyage time in the ice canopied section by 54 percent.

For all who have experienced the slow and frustrating progress of present "powerful" icebreakers through heavy ice, the penetration through heavy ridges is usually achieved only after many successive charges and the occasion often presents itself with a frequency a great deal more than once every twenty miles. In the example above, the total voyage time for a journey of 3,000 miles of which 1,000 miles are in ice canopy is increased by 30 percent if the vessel has to make one charge each twenty miles through the ice portion. If she had to do it once each mile (on average) her total voyage time would be increased by 800 percent.

The ship we have been discussing has in each case the ability to negotiate the heaviest ice and thus fulfills the requirements of an icebreaker. The economic viability, however, is disastrous unless she is built to do the job with very few stops for even a single charge each time. The capability which must be built into the ship must therefore consider power requirements for maintaining a good average speed plus the weight or mass needed to provide inertia to carry her through the largest ridges expected to occur with significant frequency over the route. Route analysis, therefore, is of the utmost importance and strict account must be taken of careful study of the ice environment in each case and over the entire route. Commercial operations are seldom predicated upon success on only occasional years. Route ice information must, to the greatest extent possible, take into account the probable conditions in bad years and their frequency.

What about icebreaker support? Well, again, we must qualify the answer by stating that this discussion is aimed principally at the bulk vessels intended to transit routes such as the N.W. Passage on a twelve-month basis. As I have pointed out, such ships must maintain a continuous speed without being stopped on more than a very few occasions for short times. The resulting size and power of such vessels will make them far more effective icebreakers than the largest professional polar icebreaker likely to be built. Normally they will go

about their business without any need for assistance whatever. However, the inevitable will happen and such a vessel will eventually sustain some kind of a failure, either machinery, propeller, hull or navigation. Under such conditions, being immobilized for a time, she may become beset and have to be broken out. Since these behemoths will, at the very least, be twin screw and most probably triple screw, it is almost inconceivable that power will be lost on all shafts. However, the loss of power on one shaft could require that she be assisted through the ice by an icebreaker. The experience gained by the supporting icebreakers "JOHN A. MACDONALD" and the "LOUIS S. ST-LAURENT" in escorting the "MANHATTAN" shows this to be entirely practical. Conditions so bad that neither vesel can break through alone are easily overcome by both vessels working together. A heavy polar icebreaker capable of handling the heaviest pack ice in the operation area is essential. But it is not necessary for such a vessel to be capable of penetrating the heaviest ridges without charging them. By the nature of the beast, the polar icebreaker is highly powered for her weight and capable of mounting many charges in a comparatively short span of time. The progress of such vessels through heavily ridged or rafted ice conditions will therefore be quite rapid even though she may frequently have to ram her way. Being relatively short with highly responsive steering system these "terriers" will also have the capability of moving around the giant ship to help turn her around or change her heading if necessary to route her out of trouble. While towing facilities will of course be provided, they would rarely, if ever, be used in the support of the giant ships.

The minimum size and power of the supporting icebreaker must be determined for the route ice conditions in which her assistance may be some day required. It is apparent that the principal requirement of the polar icebreaker is simply to have a certain capacity and to be within reasonable call. With luck she should have very little work of the above kind to do and her time will be spent doing a multitude of other chores, including scientific work, patrol and very likely maintaining open channels on principal routes to reduce ice growth between

transits. Gathering of ice data and perhaps movement of icebergs (away from harbour or route entrances) will undoubtedly be amongst her normal duties. The entire system needed for major long-term development of the Arctic Islands and North Coastal Regions will hinge upon the presence of such ships.

Icebreaker support will be essential as an ever present back-up to the commercial shipping. For the year-round operations especially those as far north as Viscount Melville Sound, the icebreaker will be of the polar type capable of reaching any part of the Arctic Islands region and will have a displacement in the neighbourhood of some 33,000 tons to 36,000. She will have a propulsion plant of at least 120,000 SHP. Perhaps more, depending upon the desired operating profile and fuel economy. For the reasons mentioned above while discussing the powering and mass requirement of the bulk vessels, the icebreaker will also show greatly improved long-term economy if provided with higher, rather than lower power. For areas in the Eastern Arctic south of Lancaster and for support in the less difficult seasons in that region and north, smaller icebreakers will be required, some of which may be in the 50,000 H.P. range and others of a smaller type to further assist the summer supply and exploration programs. With the proper combination, it may be that two of the large polar type would be adequate for the all-season work in the difficult areas to the west of Resolute, while two of the smaller variety, along with the smaller icebreakers of the size now in operation, could adequately handle those regions to the east of Resolute and southward.

<u>TUG/BARGE</u>

Considerable speculation has taken place about the possibilities for tug/barge transportation systems in the Arctic.

It is fair to say that Canada has been among the leaders of the world in the development of seagoing tug/barge systems. Operations on the Pacific Coast will testify to this. With

the advent twenty years ago of the self-dumping log barges, a new era in the deep-sea barge towing business developed and it is a matter of some pride to us that Canadian Naval Architects were responsible for much of this progress. The early barges of the fifties were initially about 6,000 d.w.t. size. These have since reached up to 10,000 ton capacity, and trans-ocean barges are under consideration up to 26,000 tons. Systems up to 50,000 tons may not be far off, where economic analysis shows advantage.

Up to the present, the method of moving a seagoing barge has been by towing. In recent years, however, the possibility of push-towing in a seaway has been increasingly studied. The Russians, Japanese and Americans have been doing most of this research. Various systems with which many of you are familiar, such as SEALINK, ARTUBAR and a more recent deep notch system developed in the U.S., have been advanced to the point where push-towing at sea is a feasible proposition. Seagoing push barge trains are farther off.

It is well known that transportation by tug and barge is often more economical than self-propelled ship. The economy of tug/barge systems are often so attractive that it is worth while to dwell for a moment on the prospects for tug/barge usage in the Arctic regions. Tug/barge is not new for moving supplies into the DEW Line and other installations in the Alaskan Arctic. They have been used for this purpose for many years. More recently large quantities of supplies have been moved by this means for the offshore drilling operations off the North Slope. Barges approaching 10,000 t.d.w. are in use for these operations, annually hauling many thousands of tons of supplies. Some have been built with ice strengthening, but so far all have been used only for service in the summer season, with limited exposure to ice. Except for the Mackenzie River system, tug/barge supply in the Western Arctic has up to now been a towing operation. The problem of moving such a combination through high concentrations of ice cannot satisfactorily be solved by towing, even when this is done on a short line. Only in light ice conditions is such a method free of serious risk of damage from ice closing in behind the tug, arresting the barge and possibly breaking the line or besetting the barge. Towing through ice close-hauled has the further disadvantage of introducing difficulties into

steering the combination as well as the ever-present risk of the tug being run down by the barge should the tug suddenly encounter an ice barrier.

Push-towing is essential if anything heavier than open water or light ice concentration is to be negotiated. To date the only attempt to push-tow through the ice was carried out in the summer of 1968 and again in 1969. In this case, a special barge was built and fitted with an Alexbow/Hammerhead type of bow. This 2,000 t.d.w. barge, LEARMONTH, after having delivered drilling supplies to Melville Island successfully in 1968 was pushed through the ice on her way out, the push tug being a twin screw vessel of some 3750 SHP. In 1969 a similar attempt was made with LEARMONTH towing another barge. This second barge, JOHNNY NORBERG, was of normal barge form without any special hullform provision for ice. During this attempt the LEARMONTH was pushed through the ice while towing JOHNNY NORBERG. While it is unfortunate that the second voyage of this combination should have ended with the loss of both barges, it would be a mistake if the loss were attributed to any inherent unsuitability of the push tug/barge concept for ice navigation. On the contrary, the two voyages of the LEARMONTH pioneered barge push-towing in ice canopied waters. One should bear in mind, with regard to the sinking, the fact that it probably would not have happened if the tug had not been impeded by towing the conventionally configured barge JOHNNY NORBERG at the time.

Aside from difficulties with the tug/barge connections, the performance of LEARMONTH showed conclusively the definite technical possibility of success in the continued development of push-tow systems for Arctic service. With improved linkages (already well developed) barges designed with appropriate ice strengthening and hull form, pushed by tugs of high power and with adequate strengthening, the extension of tug/barge services into the Arctic regions and extended seasons will become a reality.

One word about the bow form of the LEARMONTH. This, as I mentioned, was of the Alexbow type. The form demonstrated excellent potential for its ice-penetrative quality,

steerability, course-keeping quality and last but not least, its ability to "plow" the ice to either side, thereby avoiding the incidence of ice carried under the hull into the bow and, worse, the propellers and rudders of the pushing tug. It is our opinion that this form is worthy of further development and may find important applications not only for Arctic barges, but also for Arctic bulk ships of all sizes. We consider that the development work to date on the form has been inconclusive due to limited extent, negative instrumentation, uncertain measurements and problems of tug/barge connections.

However, there is a limit, as we see things, on the potential for tug/barge operations up North. As mentioned earlier in this discourse, the commercial vessel capable of operating extended or year-round service and extended geographical service to more northerly latitudes, is going to have to be slightly mighty in size and power. We have been talking about 250,000 tonners powered by propulsion plants up to 200,000 horsepower. Obviously systems of such size are not the application for tug/barge. However, we see no long-term reason why barges up to 30,000 tons d.w. pushed by tugs up to 20,000 SHP could not be entertained for extended season operations into areas where 10/10 cover up to four feet average thickness would be encountered. Such towing systems would quite naturally differ in several respects from present ones, both the tug unit and the barge. One might expect the barge design to be a modular concept, enabling units to be disengaged from the parent unit at points of delivery or pickup. The tug unit will be very large, in fact much the same size as one of our present medium Arctic icebreakers, and when not actually engaged in towing could be used as such. Further use for such a towing unit could be an assistance in handling the larger bulk carriers at terminals.

The immediate potential for the tug/barge systems in the Arctic apart from delivery of materials, is in their possible use as winter storage depots or overloading platforms in themselves. The barge SCOTTY GALL which made the trip to Melville Island in 1968 remained there for the winter as a storage barge for the supplies she brought. It is fairly evident that the need to avoid building storage facilities ashore can be an advantage during the exploration phases of a program when construction of permanent storage facilities simply adds to total costs of exploration.

Tug/barge systems with barges of up to 10,000 tons d.w. and tugs in the 8,000 H.P. range are likely to prove entirely feasible. In most cases the tug will handle the barge in pushing mode for the open water voyage as well as the ice covered portion.

It is worth emphasizing that while we believe the tug/barge concepts are valid for Arctic duties, the pushing systems have not yet been fully developed or tested for comparable conditions. They will require to be carefully studied for each proposed application, especially until Arctic tug/barge technology has been further developed. The benefit of these applications will be a trade-off of versatility, practical limits on power and displacement, extent of season, voyage distance, proposed region of operation as between the tug/barge concept and the self-propelled alternative. It is not visualized that tug/barge systems will be used for the transport of large volumes of raw ores or petroleum out of the Arctic except in possible special trades. More likely they will be used for handling some of the supply operations to the Arctic and will be dependent upon season. The giant ships will not. Two different applications.

It is generally true that the benefits of a tug/barge system are greatest on the shorter voyages. Primarily because of the short turnaround time in the typical tug/barge operation achieved through shuttle service operations. Additionally, crew costs are usually less. Voyage time, being comparatively short between turnarounds, becomes less important and the slower speed of the tug/barge combination not so important on the shorter voyages.

Today with automation and revisions to manning scales, the complement of modern merchant ships is reducing, while tug crews are increasing under the pressure of union demands. The optimum voyage distance for tug/barge operation is becoming shorter as a result. A glance at the map will show that the voyage distance from Halifax to Resolute, say close to 3000 miles, is very long. One must accept, therefore, that the opportunities for tug/barge services to the Arctic are likely to be unusual and dependent upon special situations such as the example mentioned above, where a barge was used for winter storage. The prospects are further reduced due

to the difficulty of pushing more than one barge through ice covered waters at a time. However, we believe the technical feasibility has been proven by LEARMONTH and individual applications will continue to arise.

SUBMERSIBLE TOWED BARGES

What about the submerged "dracone" type craft loaded with oil and hauled by a marine tractor? This concept would doubtless work in certain areas at certain times. The largest dracone built so far has a deadweight capacity of some 400 tons. The craft has great resilience and resistance to abrasion. Being filled with fluid cargo internally its inside pressure could be adjusted to equalize exterior pressure and depth would therefore not be dangerous. Its behaviour, however, to collision with ice floes or deep ridge keels cannot be predicted with any certainty. Considerable risk would be involved in the operation of a large unit subject to collision and possible grounding. Whether the skin could be made strong enough to withstand ice contacts for units of large size must remain for future development to decide. In any case, other problems such as protecting the towline from parting should it cross a large ice floe or field of ice would require something very special in the design of towing cables. It has been suggested that heated cables may be a solution. One cannot visualize how heating the cable could act quickly enough to cut through a floe before the impact force parts the cable. Other means of cutting through ice with the cable have been suggested. There may be a case for the dracone barge for oil cargoes in limited quantities (supply operations) but we are inclined to question the safety and economic feasibility of even these applications.

In summary, Arctic bulk transport will in the future be divided between the "supersubmarine" concept for all-season service "across the top" and to the North of 78, the super-tanker or O/B/O vessel for those latitudes and points to the south and smaller less powerful bulk ships in the Eastern Arctic south of Lancaster Sound. Tug/barge systems could be used successfully to move bulk cargoes out of the area from this point south in open water and light ice seasons, with their capability developed for extending the season up to 10/10 ice

covers to an average of 3 to 4 feet thickness. These systems will be pushing systems. Tug/barge systems of lesser power and size can be expected to be practical for a variety of supply and "wintering over" depot applications.

One can expect to see a considerable variety of special craft and hull forms evolve for Arctic service in the course of the next decade, probably beyond our expectations of the moment. With the high costs inherent in Arctic operations of every type, competitive extraction and marketing of the resources of the region will require operations to be on a large scale, for it seems likely that only those operations in which economics of scale can be achieved will be realized.

For this reason, even more than in other areas of the world less arduous, it will be essential to do the homework carefully before proceeding with the implementation of transportation systems. In this respect, it is difficult to understand how anyone (Humble included) could have been expected to implement a large tanker shipping operation notwithstanding the success anticipated from the results of the MANHATTAN tests. The unknowns for an accurate evaluation of such a program are still too great. Still unknown or uncertain, are the following:-

- Canadian Government Construction Regulations for Arctic Service.

- Canadian Government Pollution Regulations, not in final form at present. So far no plan to handle large scale oil spillage from major accidents. The system of fines or user charges still to be clearly defined.

- Hydrographic and bathymetry information in many areas still far from complete.

- A suitable navigation system, Loran "C" or equivalent, still to be set up.

- Environmental data, especially the ice movements, field pressure data and conditions, are yet to be clearly defined over all navigable areas, with maximums and averages established over many years.

- The establishment of acceptable insurance rates and a suitable basis therefor must be clarified.

It is apparent that in the present state of the knowledge, notwithstanding the vast quantities of data obtained and collated over the past several years, it is still most difficult to engage in long range planning with means for establishing risks and uncertainties within acceptable limits.

This is not a criticism. All the above mentioned items are being dealt with rapidly, some, in fact, with almost unprecedented speed. The fact is that the amount of work in all these areas is prodigious. Things are not made any easier by the shortage of comprehensive data over years gone by, but those years have gone by. They cannot be "done over again". The overall pressure brought about by the extensive and intensive exploration activities and the several large discoveries, together with the obvious and rapidly growing demand for these resource products, results in the danger that we may "run before we can walk". This could be fatal, resulting in possibly extensive damage to ecology, the sociology of the Northern peoples and ruination of one of the few remaining large geographic virgin areas of the world. The problems of pollution in its many forms, must be recognized and solutions developed before major activities are implemented on large scale. This is a question of time, for it is inevitable that development will take place in a vast region so rich in resources needed by a hungry world. From the standpoint of this author, the time is a matter of only a few years. The systems for safe navigation and safe transport of huge quantities of product must therefore be progressed with all possible speed if the risk of calamitous mishap is to be avoided.

TABLE 1

COMMODITY RESERVES *

Commodity	Area	Estimated Reserves (Short Tons)	Estimated Annual Production (Short Tons)	Life of Reserve	Probable Best Transportation Mode
Iron Ore	Mary River	130,000,000 Tons	4,000,000 Tons	30 Yrs. Plus	Surface Ship
Copper	Coppermine	4,000,000	20,000 Tons Concentrate	10 Yrs.	Surface Ship or Barge
Lead/Zinc	Little Cornwallis Island	40,000,000	300,000 Tons Concentrate	14 Yrs.	Surface Ship
	Strathcona Sound	12,000,000	60,000 Tons Concentrate	14 Yrs.	Surface Ship
Sulphur	Axel Heiberg Island	10,000,000	500,000 Tons	20 Yrs.	Surface Ship
Copper/Nickel	Tehek Lake	25,000,000	500,000 Tons Concentrate	13 Yrs.	Ground Conveyor and Surface Ship
Oil/Gas	Arctic Coastal Plain Mackenzie Bay	40 billion bbls. oil 250 trillion cu. ft.	6 million tons increasing to 50 million tons 2 million tons liquified gas		Pipeline Surface Ship or Sub-tanker

TABLE 1 (Cont'd.)

COMMODITY RESERVES *

Commodity	Area	Estimated Reserves (Short Tons)	Estimated Annual Production (Short Tons)	Life of Reserve	Probable Best Transportation Mode
	Melville Island	500 million bbls. 3 trillion cu.ft.	3 million tons 2 million tons liquified gas		Surface Ship or Sub-tanker
	Axel Heiberg	500 million bbls. 3 trillion cu.ft.	3 million tons 2.4 million tons liquified gas		Surface Ship or Sub-tanker

* Figures are published approximations or estimates.

APPENDIX

SOME COMMENTS ON "LEARMONTH" PERFORMANCE BY QUALIFIED OBSERVERS

NOTE: The following comments were made by a number of experienced and qualified persons after having personally witnessed the performance of "L.A. LEARMONTH" in Viscount Melville Sound during her journey to Melville Island in the Summer of 1968.

1. Open water seakeeping ability was considered excellent.

2. The Alexbow/Hammerhead system acts more effectively in ice of greater than 7/10 cover compared to lesser cover.

3. The path made through the ice by the Alexbow/Hammerhead bow was well clear of floating debris when operating independently of, or when following an icebreaker.

4. Ramming of solid ice floes produced a smooth decceleration of a high rate. There was no difficulty in backing away from the ice and subsequent hull examination showed that no structural damage was experienced at the point of maximum loading.

5. Barge operations are deemed a practical method of transportation in Arctic waters, provided that an appropriate tug handles a barge with inherently good icebreaking capabilities.

6. Performance runs showed that the tug/barge combination was able to sustain speeds of 9.5 feet per second ($5\frac{1}{2}$ knots) in ice about $2\frac{1}{2}$ feet thick and that this speed was only slightly less than the speed she achieved in open water. Thus, it appears that the energy expended in breaking and clearing the ice in this trial was only a small fraction of the total power required for propulsion. Bearing in mind that the power was approximately 3,750 SHP and the breadth 50 feet with a total displacement of tug plus barge of approximately 4,000 tons.

7. In ice, if it is mandatory to tow a second barge, the second barge must also be fitted with the Alexbow/Hammerhead type bow (to stop ice build).

8. Close haul towing of the second barge created difficulties in steering the tug with its icebreaking lead barge.

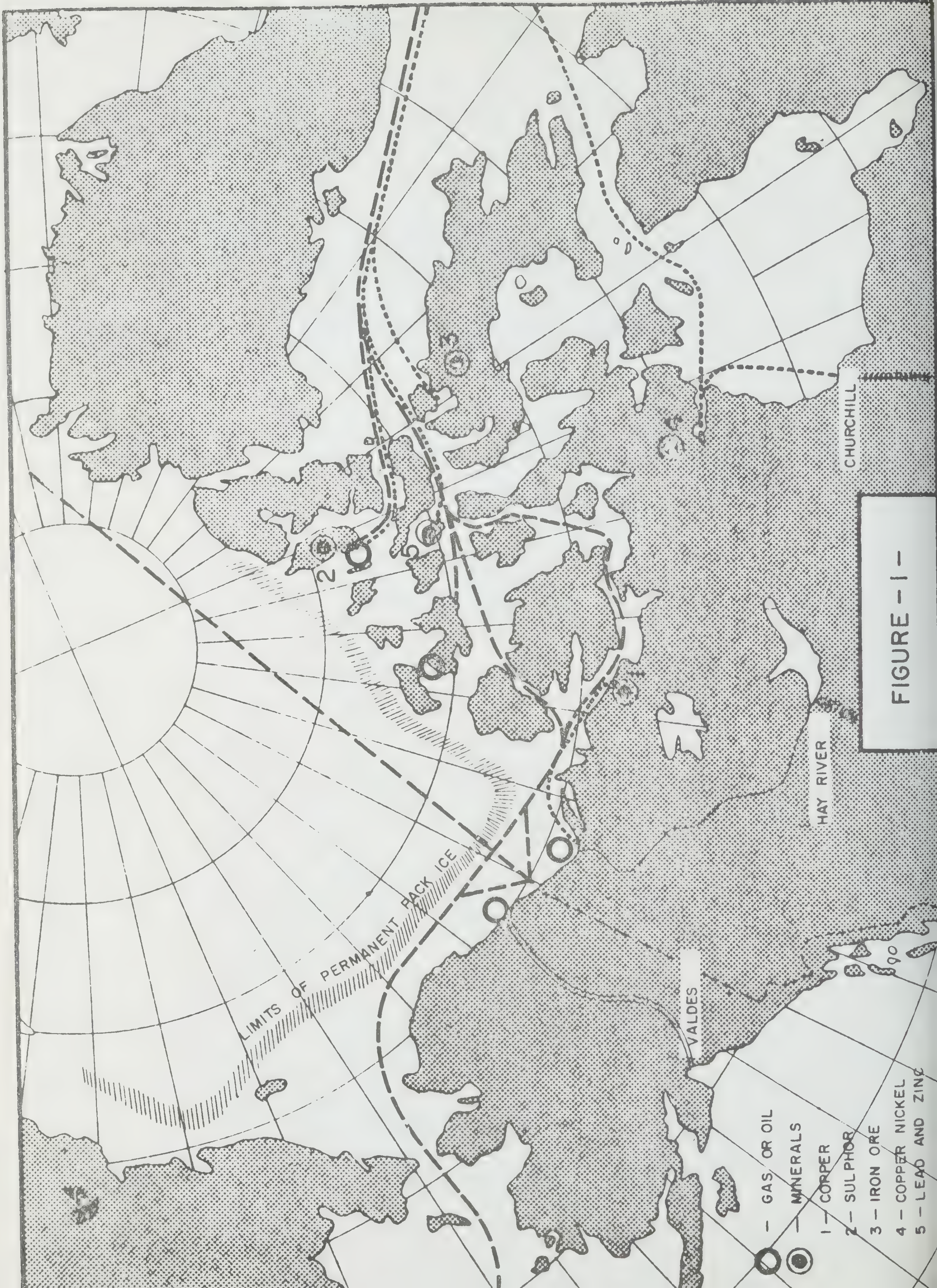
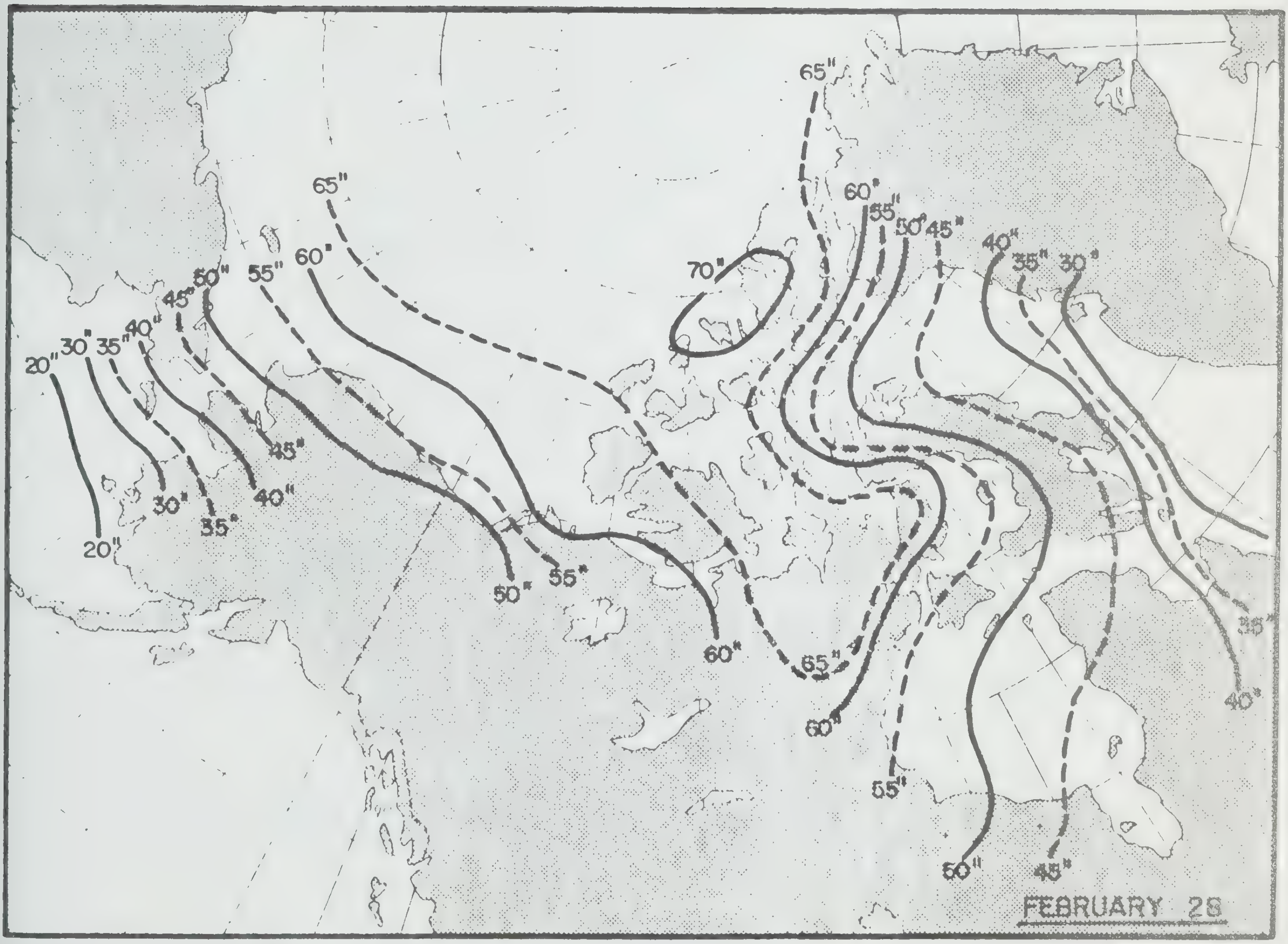

CHURCHILL
HAY RIVER
VALDES
LIMITS OF PERMANENT PACK ICE
GAS OR OIL
MINERALS
1 - COPPER
2 - SULPHOR
3 - IRON ORE
4 - COPPER NICKEL
5 - LEAD AND ZINC

FIGURE - I -

MEAN THICKNESS FIRST YEAR ICE

(TYPICAL CHART)



NORTHERN ASSOCIATES REG'D.

FIGURE -2-

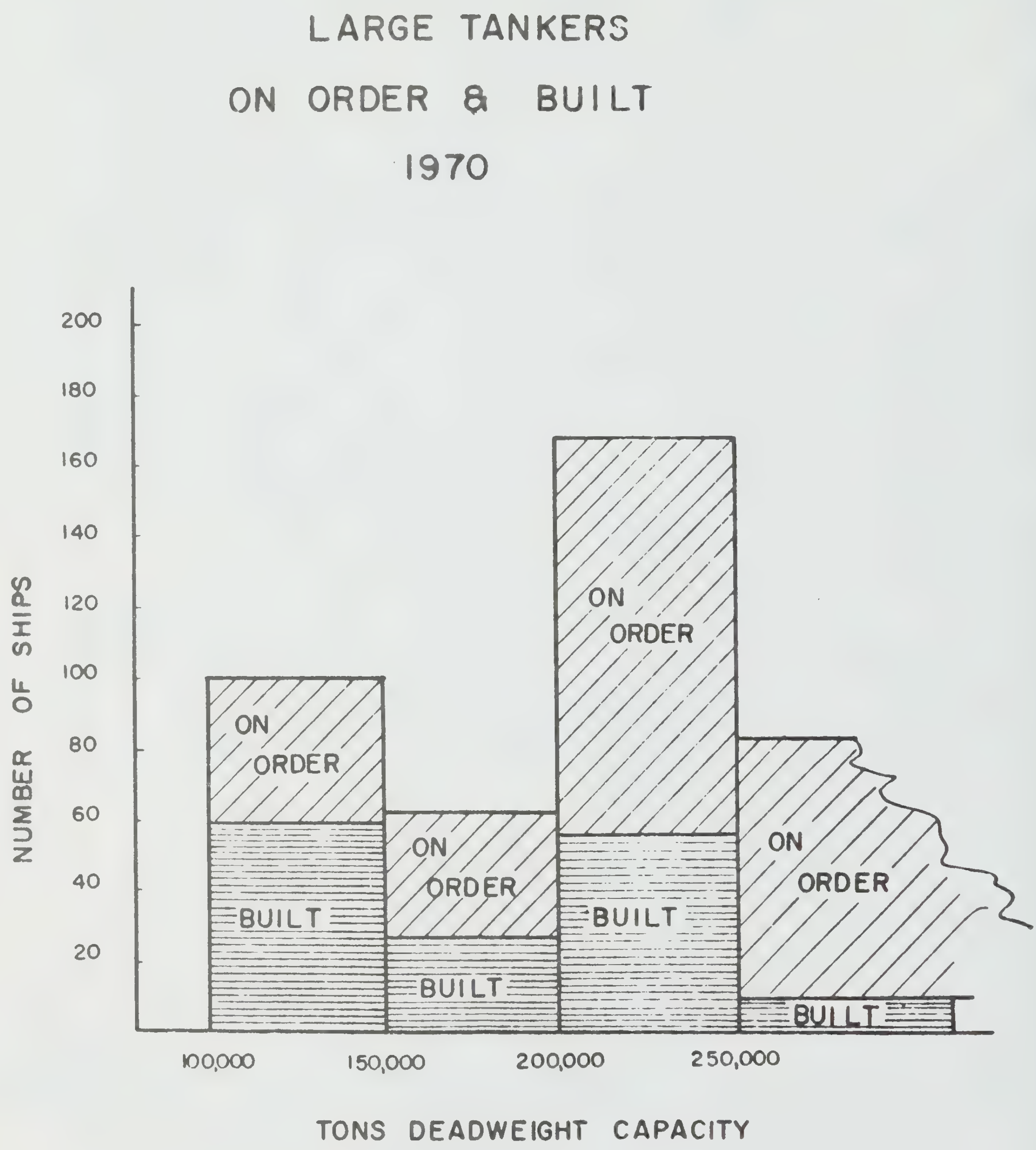

LARGE TANKERS
ON ORDER & BUILT
1970
NUMBER OF SHIPS
200
180
160
140
120
100
80
60
40
20
ON ORDER
BUILT
ON ORDER
BUILT
ON ORDER
BUILT
ON ORDER
BUILT
100,000
150,000
200,000
250,000
TONS DEADWEIGHT CAPACITY

FIGURE -3-

POWER REQUIREMENTS FOR AN

ICEBREAKING BULKSHIP

OF

200,000 TONS DEADWEIGHT

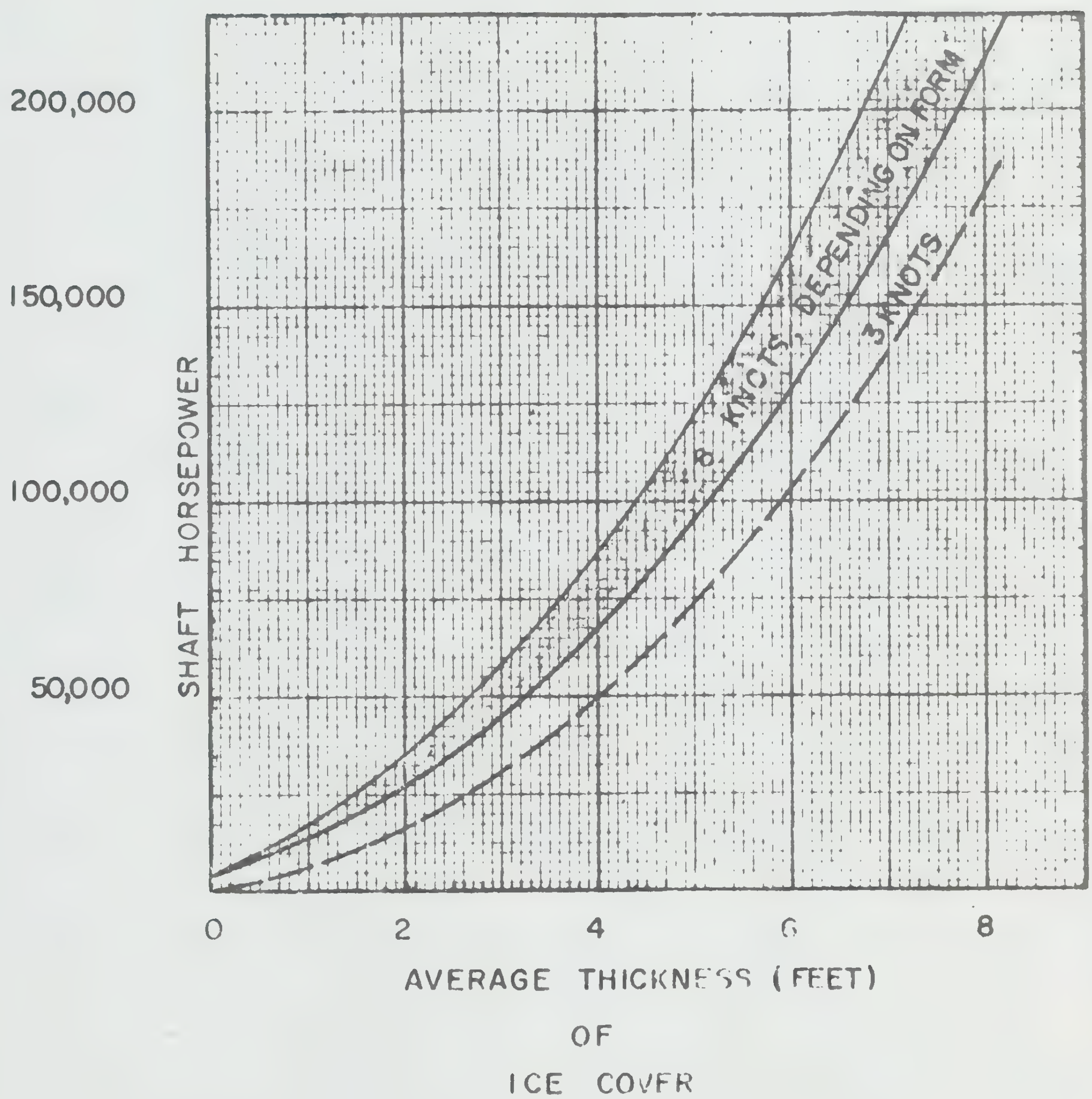


FIGURE -4

ALEXBOW

HAMMERHEAD BOW

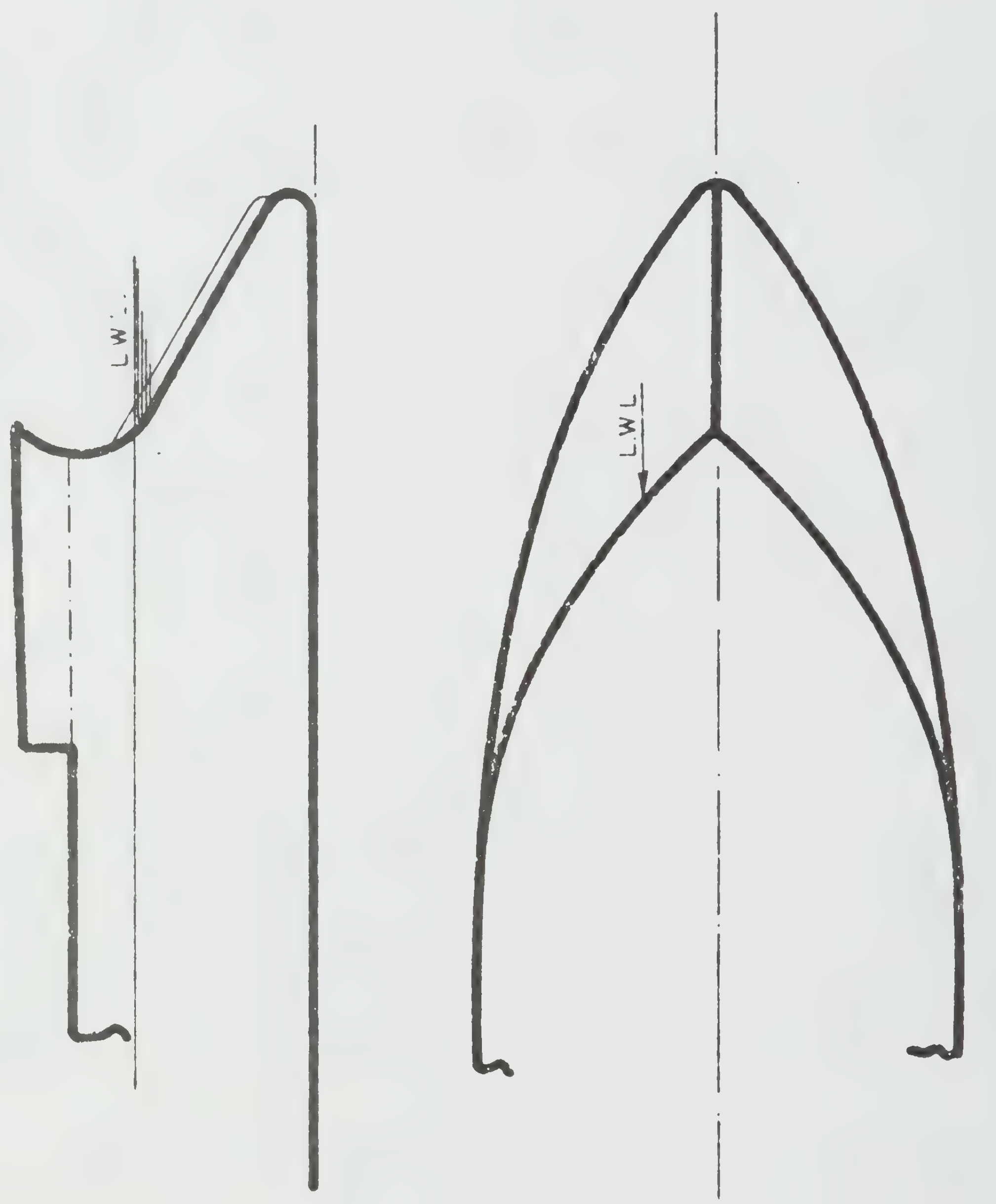


FIGURE -5-

"WHITE "ICEBREAKING" BOW

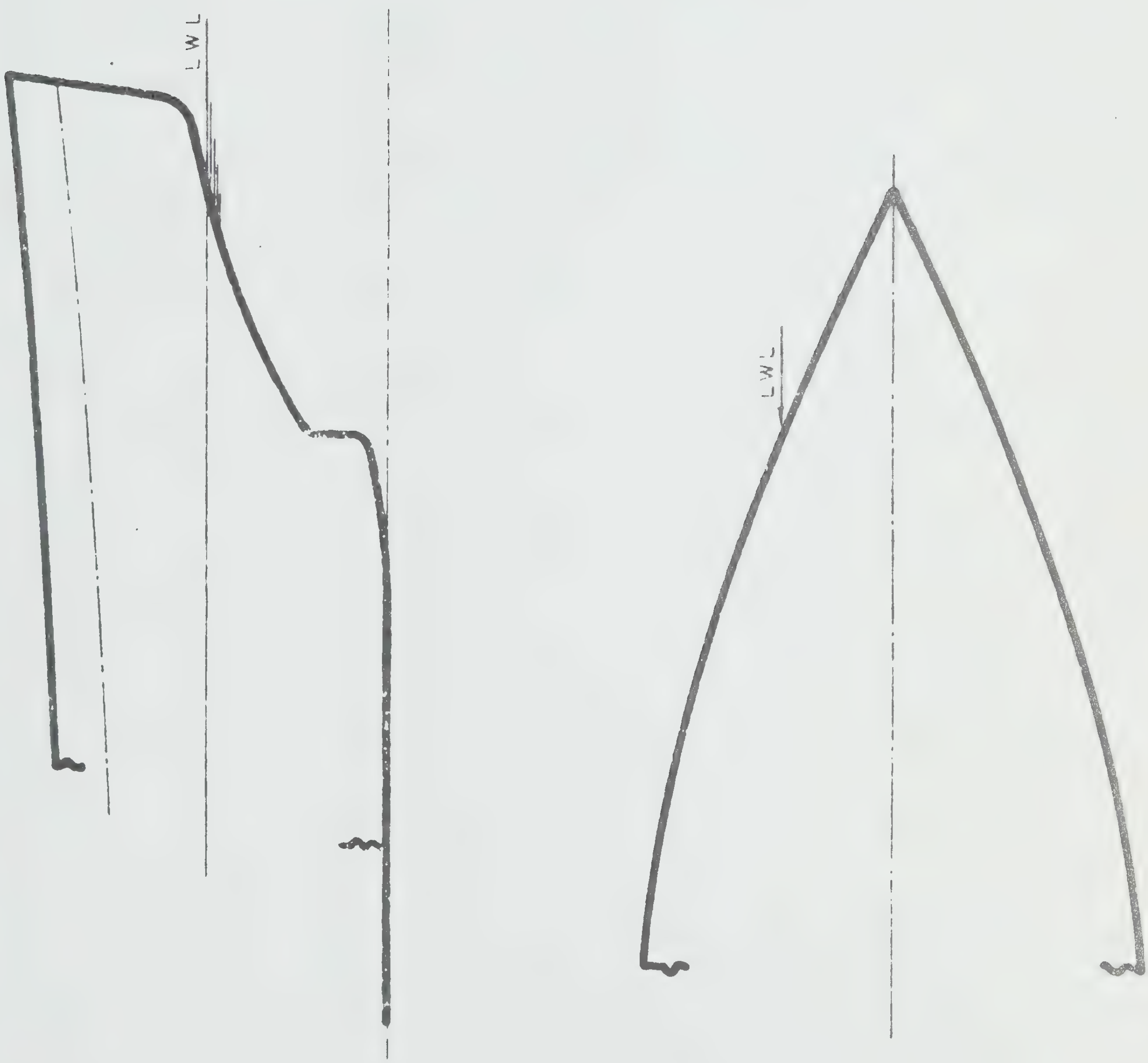


FIGURE -6-

MARITIME BULK SHIPPING & ICEBREAKER SUPPORT

BY: MR. R.S. GROUT
Manager, Marine Division,
Transportation Department, Imperial Oil

At the outset I would like to express my appreciation to the sponsors of this conference - the Department of Transport and the Department of Indian Affairs and Northern Development - for the opportunity to participate in these discussions. Forums such as these, which provide for a free exchange of information, ideas and views on the forward development of the Canadian Arctic, cannot help but prove to be beneficial in the long run to government, industry and the inhabitants of this vast region.

I realize that many of the participants and attendees at this conference have an intimate knowledge of the Arctic obtained over many years of experience and work in the area. For this reason I would hasten to explain that my actual experience is limited to one short visit in September 1969 in connection with the first Arctic voyage of SS "Manhattan". In addition it should be noted that my business experience is limited to the oil industry and, therefore, any of my comments relative to mineral development are those of an outsider.

The subject matter of this panel "Maritime Bulk Shipping and Icebreaker Support", is an exciting one as it is concerned with the possibilities for a major technological break-through in commercial shipping. Without such an advance in transportation technology, the development of a large portion of Arctic Canada's potential resources, I submit, will be impractical. It is an

economic fact that a potential natural resource only becomes a real resource when it can be brought to market at a competitive cost. This hard reality must be recognized, particularly in the case of relatively low value bulk materials such as petroleum and base metals. This is the situation we face in the development of much of the Canadian Arctic and is the basic factor underlying my comments on the specific subject of bulk Arctic shipping.

In my approach to this subject I have chosen to arrange my remarks under six broad headings. To set the stage it would seem desirable to identify the geographic location of possible commercial discoveries of minerals and petroleum that might be moved to market by ships.

Secondly, a general evaluation of the possible markets for such commodities will, I feel, be of interest. As a third step, and in continuance of the geographic approach to this subject, I will discuss (speculate on) the severity of the obstacles to navigation by areas in the Arctic.

With these factors in place I would like to draw attention to some of the differences, as I see them, between mineral and petroleum development in the Canadian Arctic from a shipping point of view.

From this rather broad appraisal of the general subject I plan to turn to a discussion of the specifics of the cargo ships, icebreaker support and other facilities that might be required. This portion of my remarks will be , of necessity, oriented to the petroleum industry.

As a sixth and concluding step I would like to offer some

general observations with respect to the opportunities for the bulk shipment of commodities ex the Canadian Arctic to market by the surface marine mode.

On Exhibit I the current known promising mineral discoveries are identified along with a delineation of those areas containing sedimentary rocks in which oil and gas might be discovered. To date an oil discovery has been made at Atkinson Point in the Mackenzie Delta and gas has been discovered on Melville and King Christian Islands. By themselves none of these discoveries appears commercial at the present time.

The promising mineral discoveries, to the best of the author's knowledge, are the iron-bearing deposits of the Labrador trough which touches on tidewater at Hope's Advance Bay; the nickel discovery in the Ungava nickel belt; asbestos some 50 miles inland from Deception Bay on the Hudson Straits; the iron-rich deposits at Mary River inland from Pond Inlet on Baffin Island; lead/zinc at Arctic Bay on Baffin Island and copper inland from Coppermine on Coronation Gulf in the western Arctic. With the exception of the last mentioned copper find, all of the commercially-promising mineral discoveries are located in what can be broadly described as the eastern Arctic. This is a significant point with respect to ship/navigation considerations and will be referred to later in this discussion.

Probable market areas for minerals and petroleum ex the Arctic by ship are, not surprisingly, similar and reflect the geographic location of the Arctic relative to the major industrial areas of north-eastern United States, North Europe and Japan. This

point is illustrated in Exhibit II and it is significant to note that the distances by ship from the Mackenzie Delta to these three major raw material consuming areas are roughly the same. Canadian Arctic island oil, it should be noted, might well find eastern Canada and the U.S. east coast its first market.

For logistical reasons, I have omitted as a high potential market for Arctic minerals and petroleum via the marine mode, the industrial "heartland" of the North American continent - Chicago, Detroit and Cleveland. This area does represent a potential market for Mackenzie Delta oil but would most probably be served by continental pipelines. With respect to minerals the additional distance, the constraints on ship size set by the St. Lawrence Seaway and the circumstance of a closed shipping season would seem to rule against sale in this market versus the alternatives of the shorter distances and simpler sea voyages to the markets on tidewater mentioned above.

This discussion of probable markets has been purposefully brief and general, as the intent is merely to indicate possible shipping routes. Specific opportunities for bulk marine shipping will require careful examination of market demands, the pricing mechanism in force for the commodity and, in some cases, the economic policies of national governments.

Any examination of the possibilities for commercial bulk shipping of commodities ex the Arctic to market requires an evaluation of the environmental obstacles to navigation. On Exhibit III the Canadian Arctic has been divided into segments or zones and the numbers indicate an estimate of the severity of the ice conditions that might be encountered. Zone I, which encompasses

generally the northern portion of the Arctic islands, is considered to be the most formidable and,as the numbers increase,the severity of the obstacles to navigation decrease. The author is indebted to the Meteorological Branch of the Department of Transport for this information and I am sure its most competent staff would appreciate the qualification that the segmentation presented represents a rather broad generalization of a most complex subject. For instance, for certain specific requirements, it would be necessary to introduce data with respect to seasonal variations in the environmental conditions before a valid conclusion could be reached. In addition to this reservation, I would like to make one personal observation in that the resistance to continuous ahead progress for ships, presented by pressure created by wind on large fields of ice, may have been somewhat discounted in the rankings portrayed on Exhibit III. This factor, I feel, may be of particular significance in the Baffin Bay and Beaufort Sea areas (Zones 13 & 4) during certain time periods.

There are three major, general conclusions that I believe can be drawn from the data as presented on Exhibit III. Firstly, the obstacles to navigation in what might be described as the eastern Arctic, where the principal promising mineral discoveries are located (with the exception of the Coronation Gulf area copper deposits) are relatively moderate. My remaining two observations are related to petroleum development. The second most severe area (Zone 2) includes the western portion of Viscount Melville Sound, through which ships carrying Mackenzie Delta oil would have to pass. The most severe area (Zone I) includes much of the Sverdrup Basin which is considered by some to be of particularly high potential.

At this point I would like to identify some of the differences,from a shipping point of view, between oil and mineral development in the Arctic. Perhaps the most fundamental one is that oil is a liquid which requires relatively high cost storage in the form of tank vessels while minerals can be stockpiled at a more moderate cost. It is thus much more economically feasible to maintain continuous production of the finished product, in the face of a restricted shipping season if the raw material is dry mineral rather than liquid petroleum. This requirement for high cost storage, in the case of oil, weighs heavily against proposals that have been advanced for two stage marine transportation systems whereby the oil is moved to an ice-free location by specially designed vessels and then, as a second step, to market in conventional, lower cost ships.

A second basic difference between oil and mineral development in the Arctic is the economic need to conduct, in most cases, some processing of the raw material, at minesite in the case of minerals. This processing is required simply to remove elements of little or no value from the mineral-bearing material and thus eliminate economic waste in transportation.

With respect to oil, and with the exception of the possible need for gas separation, the opposite is the case. All of the material produced has value and it is much more preferable to move the oil unfinished to its various markets where it can be refined into petroleum products, on a yield basis consistent with the demand requirements of the particular market. In this way marketing flexibility is maintained and the value of the resource protected.

From a shipping point of view this difference in the approach to primary processing will probably result in generally higher value cargoes for minerals ex the Arctic than for oil.

In terms of protection of the environment, it would seem that oil would be a more significant potential threat than minerals. With respect to the integrity of the ship and, therefore, the safety of the crew, the mineral carrier, however, presents a potentially greater hazard. This is due to the high specific gravity of minerals which results in a low utilization of the volumetric space in the ship. Large void areas are, therefore, present within the hull and present, in the event of hull factures or breaches, an immediate threat to positive buoyancy. An oil tanker, fully laden with cargo or water ballast is generally a more difficult vessel to sink. Both of these matters, protection of the environment and safety of life at sea, should receive consideration with respect to design criteria, operating practices and the availability of support and rescue equipment.

At this point I would like to discuss more specifically the possibilities for commercial bulk shipping ex the Arctic. My comments are based on assessments made by the oil industry but I believe have general application for minerals as well.

The two Arctic voyages of SS "Manhattan", along with much other research conducted by Humble Oil and Refining Company and its partners in this effort, have established the technical feasibility of year-round surface bulk shipping along the route of the first voyage. With respect to the possibilities for submarine transportation for bulk commodities ex the Arctic, I will leave any detailed

examination of this subject to the more technically qualified members of this panel and make only one general observation. Based on current knowledge, there appear to be significant reservations with respect to both the technical and economic feasibility of such an operation.

To return to surface shipping, it will be noted I stated above it was technically feasible. I am sure that many of the participants at this conference have read or are aware of a recent statement by Humble Oil to the effect that they had concluded that the use of icebreaking tankers to transport crude oil from Alaska's North Slope to U.S. markets is commercially feasible. While this may be the case for Alaskan oil, it would not necessarily be so for Canadian Arctic oil. Oil from the state of Alaska is regarded as domestic and has access to the protected U.S. market at domestic prices. Canadian Arctic oil might have to compete in the U.S. and other markets with oil from other sources on an open market basis. Thus, a lower transportation cost may be required for Canadian Arctic oil.

The technical feasibility of surface marine transportation in the Arctic is closely linked to the significant increases in ship size for bulk ocean carriers that have occurred over the last five to ten years. While much has been written about improved bow configurations and other new developments in design for ships operating in ice, I submit that by far the most important development has been the sheer increase in size of the ships contemplated for use in the Arctic. It is the mass and weight of these ships, along with suitable horsepower of course, that has made the operation technically feasible.

Humble's studies were based on a 1,250 ft. ship of 300,000 deadweight tons. Minimum power requirement is directionally estimated at 600 to 800 horsepower per foot of beam (approximately 110,000 to 150,000). The ships would be built to sustain the conditions anticipated and would be of a class much higher than any existing classification society specifications. I will leave the details of design, construction materials, propulsion and special equipment to other members of the panel but should emphasize that the particular requirements of the trade will result in a much higher investment cost than is the case for conventional ocean-going bulk carriers.

The size of ship is not only key to the technical feasibility of the operation but is highly relevant to the economics. The development of the large "super" bulk carrier, with little change in manning scales per ship, has resulted in an industry which today is highly capital intensive. Currently over 60% of the transportation cost of a ton of oil moved by a 250,000 deadweight ton ship from the Persian Gulf to North Europe is directly related to the initial investment. In the case of Arctic tankers, with a higher investment cost per deadweight ton, this percentage will obviously be much higher. Manning and operating costs should not be particularly critical to the economics of bulk Arctic marine transportation.

While the investment cost per ship will be extremely important to economic feasibility, the number of ships required to deliver a given quantity of minerals or oil to the smelter or refinery, which will process the raw material, will be more important as it will determine the total investment in ships required. The number of ships required for a given volume of material will obviously be a

function of the average round-trip time that can be achieved. Additional voyage time will mean additional investment in an operation that is already highly capital-intensive.

I previously commented on the adverse economic effects of a closed season to marine crude oil transportation in terms of the investment that would be required in tank storage. Any significant limitation in the shipping season would also increase the number of ships required and, therefore, the total investment in ships.

From this discussion of costs and economic feasibility, I would like to turn briefly to some of the operational considerations. The large icebreaking bulk carrier would be designed to make the transit without escort by a specialized icebreaker and without assistance of any kind on a high percentage of her voyages. There may be occasions, however, when some assistance would be desirable, i.e., when the large bulk carrier was delayed or possibly for entering or leaving a harbour.

The Arctic, I believe, does not present any problem with respect to navigational aids that are outside our present knowledge and technological capacity. Radar would be used for both fixing of position relative to land and for the delineation of ice conditions ahead. Equipment such as Loran and Omega is available for geographic fixing.

The environment will necessitate special attention to maintaining the vital systems for personnel safety for long periods, i.e., heat, emergency lighting, food, etc. Fire fighting capability

for the most severe weather conditions will also be required. In addition to lifeboats, the provision of a vehicle capable of operation in water and on ice would seem desirable. While the environment of the Arctic presents some new hardships to seafarers I am confident that a new breed of mariner would materialize to meet the challenges.

The location and design of loading terminals has been the subject of research by both the oil industry and the Canadian government. While I am not aware of the details of these studies I understand it is technically feasible to provide the facilities required. Actual design would, of course, be highly dependent on the location and would determine the investment required. This aspect does not, therefore, appear to present an obstacle to the technical feasibility of bulk commercial shipping ex the Arctic.

Any discussion of the marine movement of petroleum in the Arctic must, I believe, include an examination of the possible hazards presented by such an operation to the environment. While the oil industry has taken,and is continuing to take, steps to introduce measures designed to eliminate oil spills, the potential hazard still exists and as long as it does, it cannot be ignored. With this in mind, the oil industry, along with governments and other concerned bodies, has initiated research to determine better methods of handling oil spills and to secure a greater understanding of what the potential threats to the ecology really are. While I am confident that more effective methods to prevent spills will be developed, along with a more precise definition of the problem and better techniques to handle it, I recognize this will take time.

With the recent announcement by Humble Oil and Refining Company of its decision to concentrate its current efforts on pipeline transportation of crude oil from the North Slope, I submit both industry and government have been given additional time to consider the requirements of the marine case.

In conclusion I would like to make some general observations from the points I have raised in this discussion. First, commercial shipping of minerals ex the Arctic to market may well precede that of oil due to the more favourable geographic location of many of the mineral deposits and the better chance of economically sustaining the circumstances of a closed shipping season.

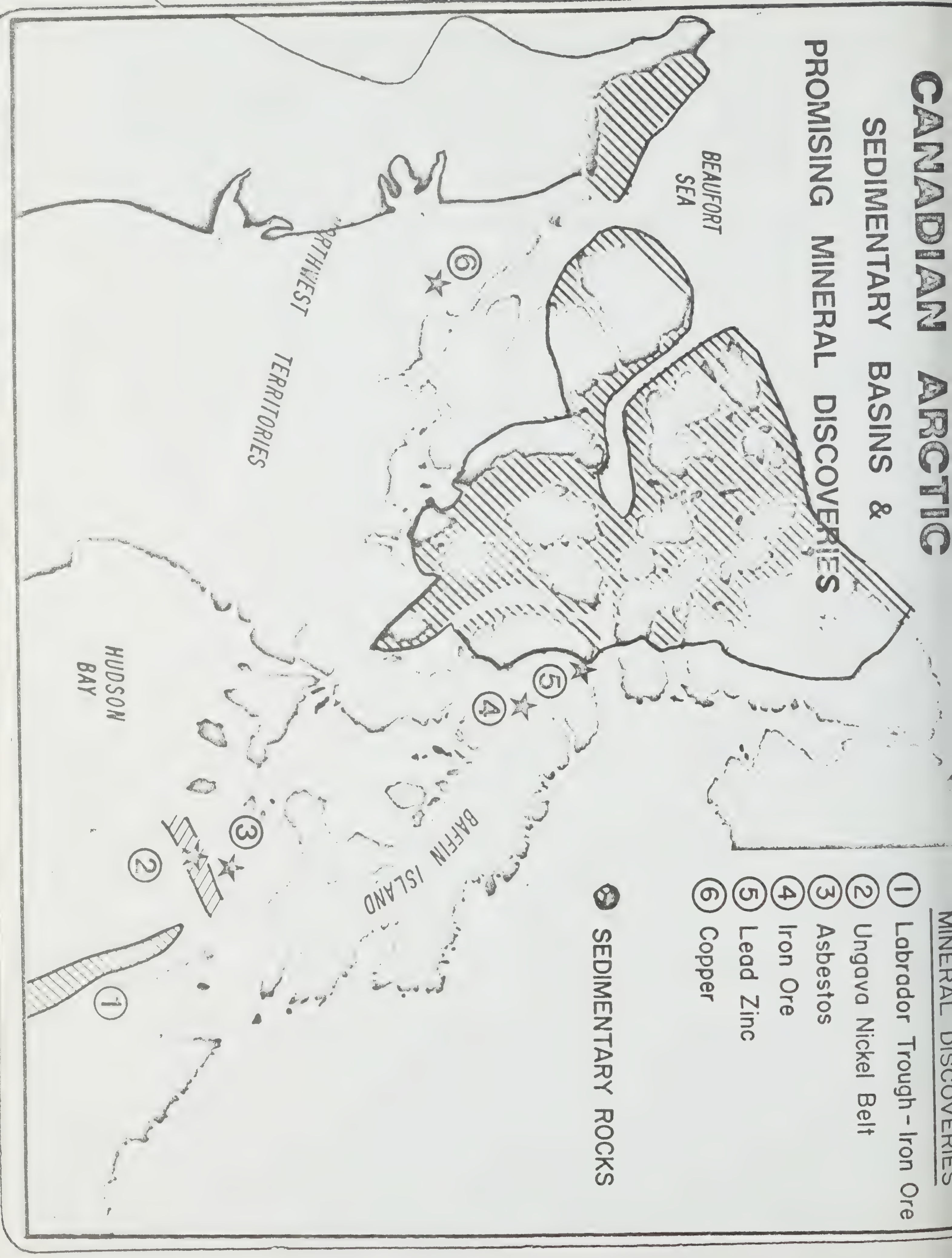
Secondly, while marine transportation of Canadian Arctic crude oil appears technically feasible, it may not be economic.

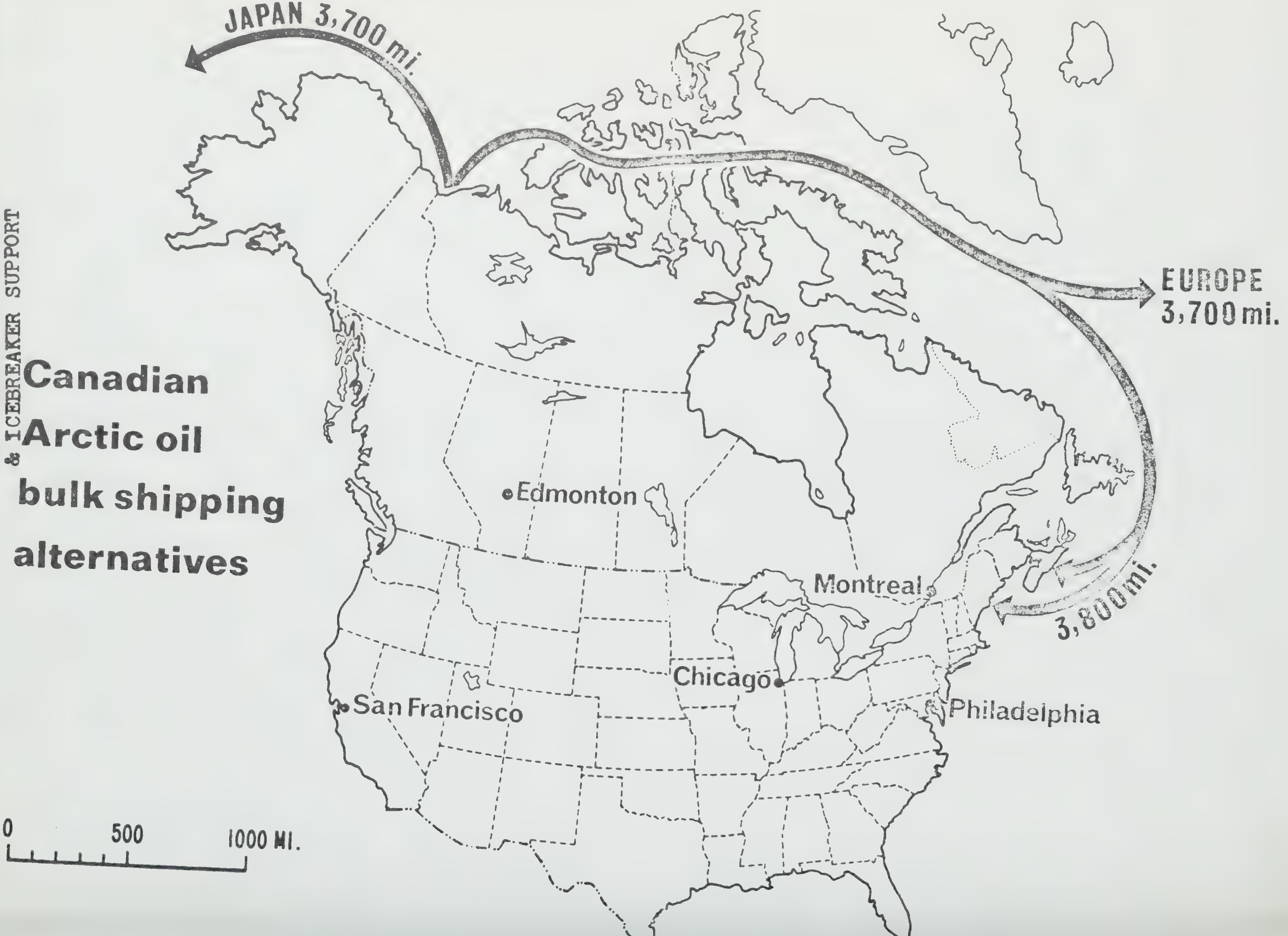
A third point, and one which I have not previously specifically alluded to, is that while crude oil discovered in the Mackenzie Delta could be moved by pipeline rather than by ship, no such alternative is technically feasible today for oil discovered in the Canadian Arctic islands. This is because the water depths between the islands and the mainland preclude pipeline construction. Given current pipeline technology, commercial development of Canadian Arctic island oil will require marine transportation.

My final observation is that recent developments would seem to indicate that government and industry have more time available to study and appraise the technical and environmental problems that may be associated with commercial bulk shipping of oil ex the Arctic. I have highlighted the sensitivity of the economics of

marine transportation to capital investment. It is hoped that ship design and operating regulations will be framed only after as complete a review as possible of the requirements for year-round navigation has been conducted. Such an approach will encourage the continued investigation and development of marine transportation for bulk commodities ex the Arctic.

Prepared by
R. S. Grout
November 12, 1970


CANADIAN ARCTIC
SEDIMENTARY BASINS &
PROMISING MINERAL DISCOVERIES
BEAUFORT SEA
RTHWEST
TERRITORIES
HUDSON BAY
BAFFIN ISLAND
MINERAL DISCOVERIES
1 Labrador Trough - Iron Ore
2 Ungava Nickel Belt
3 Asbestos
4 Iron Ore
5 Lead Zinc
6 Copper
SEDIMENTARY ROCKS


Canadian Arctic oil bulk shipping alternatives
JAPAN 3,700 mi.
EUROPE 3,700 mi.
3,800 mi.
Edmonton
Montreal
Chicago
San Francisco
Philadelphia
0
500
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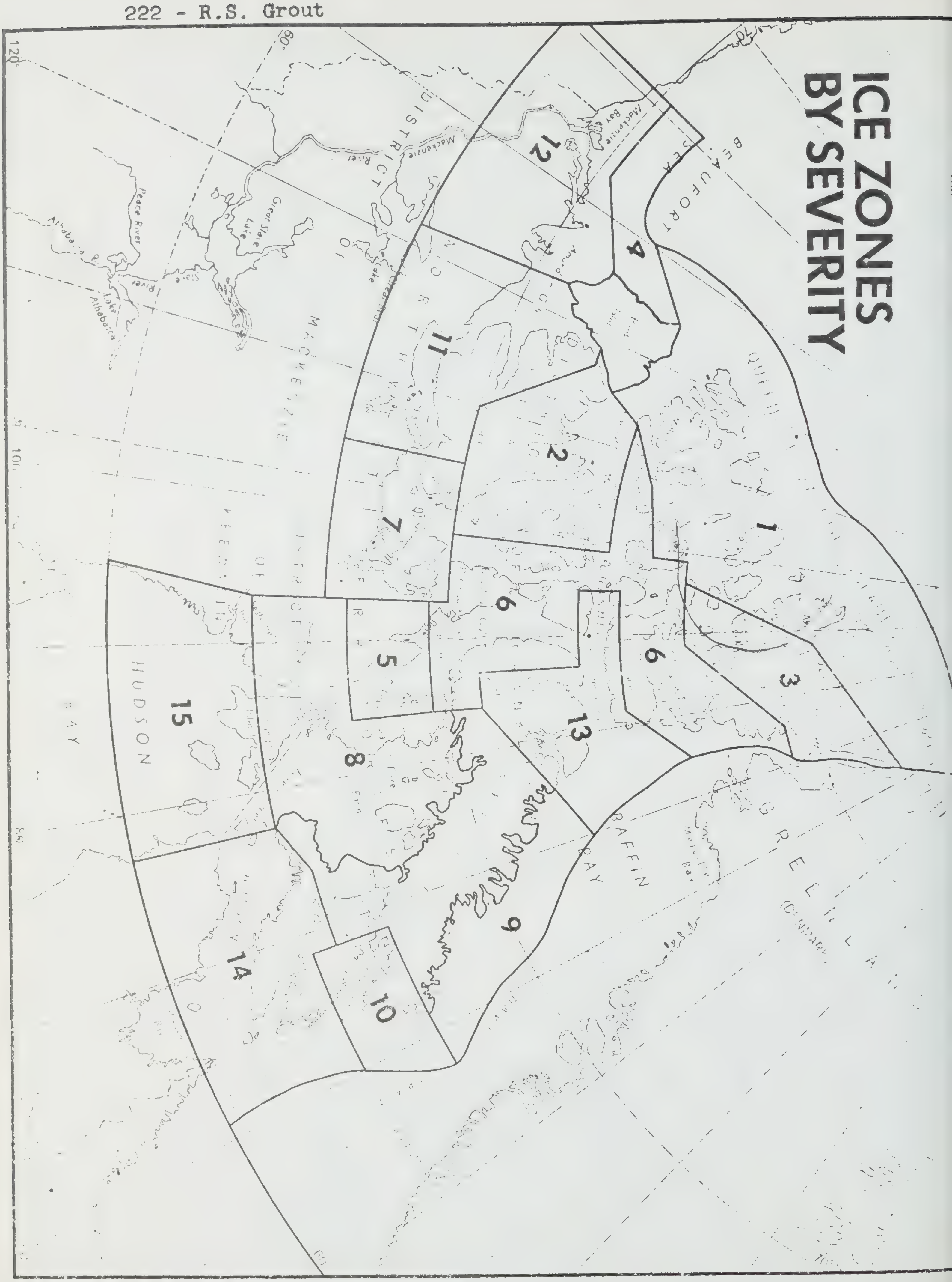
ICE ZONES
BY SEVERITY
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MARITIME BULK SHIPPING & ICEBREAKER SUPPORT

BY: MR. D.M. RIPLEY
Director, Marine Hydraulics,
Canadian Marine Transportation Administration

INTRODUCTION

Until comparatively recently a major operation involving transport of bulk materials by water in the Arctic seas has been considered to be impractical, if not impossible. It has been generally believed that a successful transit of the Northwest Passage was but an historical event, admittedly great stuff for adventurers and scientific types, but not likely of any foreseeable commercial merit. Now suddenly a new optimism has become evident, stimulated by the reality of oil discoveries, such as Prudhoe Bay and the Mackenzie Delta region, and the challenge of the recent experimental voyages of the tanker "Manhattan". Such events are of particular interest to the maritime shipping industry because they confirm the presence of a large volume of potential bulk cargo. They confirm also that our technological development has advanced to the point where it may be possible and perhaps economic for ships to cope with the severe Arctic environment. In this display of enthusiasm we should not lose sight of reality nor should we forget that such spectacular events are but a manifestation of the work of the explorers, navigators, scientists and other plain patient people, who, through their probing and analyzing the secrets of the North, provided the basis for these accomplishments. Indeed, if a bulk shipping operation in the North is to become a reality it will be the result of more of this kind of solid fundamental work.

Geological evidence and actual discoveries of oil and minerals support the widely held opinion that the North of Canada is a vast storehouse of resources. Accelerated exploration activity, together with an increasing confidence in our capabilities and effectiveness, will undoubtedly lead to a rapid move forward in the development of these resources for the general benefit of Canada. Resource development requires an access to markets for products. Therefore, one can forecast readily enough a corresponding escalation in demands for all kinds of transportation facilities and services.

Certain commodities are obvious cargoes for water carriage because they must be transported in large volume to distant markets. In the case of potential shipments from the Arctic Archipelago at our present stage of transportation science, there is no apparent alternative to water transportation. The shipping industry should not be too smug about the apparent advantages of the marine transportation role in certain regions of the North and assume that a lot of new business will automatically fall their way. Successful shipping operations in the North will continue to depend mainly on economic viability. Demands will be made on efficiency and dependability. In the absence of such qualities, the markets will be captured by competing transportation modes; either that, or exploitation of the resources will not proceed at all in the absence of an economic transportation mode. The point is that water transportation will be the key to economic viability in the case of many of our resources in the North.

The conventional concept of water transportation in the Arctic is based on the utilization of well-powered surface vessels, strengthened

for resistance to damage by ice, that operate with some provisions for icebreaker assistance. This is the popular concept because, through experience we now have gained quite certain evidence as to the capabilities of this system. We should admit, however, that there may well be other water transportation systems of greater effectiveness. More will be stated later on concerning some of the more imaginative proposals in this connection.

There will be a larger place in the North for maritime bulk shipping; this much we can state with confidence. To go beyond this point to give at this juncture unqualified predictions of cargo sources and volumes, operating systems and a time frame of development would be a risky undertaking. We can, however, take a look at the alternatives and hopefully suggest a trend.

POTENTIAL BULK CARGOES

Among the known and potential reserves of oil and minerals in the Arctic that are potentially future ship cargoes are the possible major oil and gas pools in the Mackenzie Delta and Queen Elizabeth Islands, high grade iron ore deposits in north west Baffin Island, as well as copper, lead and zinc deposits at Coppermine, Strathcona Sound and Little Cornwallis Island respectively. These commodities have been expressed as known and potential reserve estimates on Table 1. A forecast of potential

reserves of oil and gas alone is given in Table 2, and it may be noted that the potential is already equal to that of the Western Canadian Sedimentary Basin, and is twice that of the Eastern Canada offshore area. In addition to these known and potential resources, the Sverdrup Basin may contain reserves of natural sulphur.

In considering the location of these resources it may be seen from Plate 1 that the major oil and gas potential is to be found west of Resolute, while the known major ore reserves requiring bulk shipment are east of Resolute, as indicated in Plate 2. In fact the major iron ore reserves are at the outer limits of the Eastern Arctic in the north west of Baffin Island. The discovery of the four principle iron ore bodies at Mary River was made between 1962 and 1965, and they were confirmed to be one of the world's largest high grade ore reserves. It has been indicated that an annual rate of four million tons would be required to derive an optimum profit from a mining operation.

Generally speaking only the higher grade mineral deposits are being brought into production in the North because of the high cost of transportation. Maritime bulk shipping has never been able to be competitive for any relatively small high value tonnages to be transported. It is probable that the other established modes will continue to handle such materials; indeed, aircraft and the more sophisticated surface vehicles are likely to improve their present competitive position and, accordingly, capture a larger share of this business.

The consensus appears to be that the random growth in investment in exploration and development of the resources of the North will continue into the future, quite probably at an accelerated rate. Moreover, the locations of proven and potential oil and mineral reserves are widely separated, which suggests that each development will tend to do its own thing and make unique demands on a maritime shipping service. In the circumstances, it is difficult, to say the least, to make any kind of forecast of cargo volumes that may be shipped out by sea. The most optimistic forecast would assume a happy coincidence of a full realization of exploration indications, a stronger world market demand and a major breakthrough in shipping technology. Under these most optimistic circumstances, and considering that the most attractive opportunities for the maritime bulk shipping in the long term would seem to be tied in with movement out of the Arctic of ores, oil and liquified natural gas, it is possible that within the next decade there will develop a demand for ship capacity to move out of the Arctic annually some five million tons of ore and concentrate, 288 million barrels of oil and two million tons of liquified natural gas (1). The potential magnitude of the operation is truly formidable and could require annually some three hundred voyages of bulk carriers of the 200,000 ton class.

The emphasis in the foregoing has been placed on potential bulk cargoes out of the North in the long term. When considering these prospects

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(1) Forecast of possible ship requirements by Developers of Non-Renewable Resources, Department of Indian Affairs and Northern Development.

we should not overlook the expanding bulk and general cargo shipped into the Arctic as a part of the Arctic re-supply operation and sealift. Cargoes, although at present of relatively modest volume, are increasing rapidly. During the past summer some 130,000 tons were taken into the Eastern Arctic by sea, and it has been estimated that these cargoes will increase to 175,000 tons by 1975 (2). At some point in time, as exploration phases into development activity, there will be more use made of the indigenous materials, but there is no doubt that there will always be a dependable volume of cargo inbound.

SHIP AND ICEBREAKER OPERATIONS IN THE ARCTIC

Over the years there have been some cautious attempts made to find answers to some of the problems associated with maritime transportation in the ice infested waters of Canada's seacoasts. The Arctic icebreaking probes of the Canadian Coast Guard throughout this decade have increased our understanding of these waters, while the experience of the 50,000 d.w.t. ore carriers of the Navios Corporation trading from Sept Iles and Port Cartier in the Gulf of St. Lawrence has added greatly to our knowledge of large cargo vessel operation in ice. The recent Manhattan trials represented an attempt to take a major leap forward in ice navigation. While not as completely successful as may have been hoped, these trials have stimulated a whole new look into water transportation in the North

During the early sixties the icebreakers of the Coast Guard represented the only form of Canadian shipping capable of ranging over a

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(2) Potential Marine Transport activities in the Arctic, German and Milne.

great part of the Arctic Archipelago during the summer months. This capability was exploited for scientific purposes when the demands for icebreaker support by the sealift operations permitted. In addition to carrying cargo to settlements, extensive hydrographic and oceanographic surveys were conducted. This work has seen the outer limits of operations and the length of the shipping season being cautiously extended as more experience and confidence has been gained. This year, for example, in addition to the seven ships under charter to the Ministry, a total of twenty three ships were under contract to private enterprise, mainly for the supply of oil exploration activity in the high Arctic. The ships ranged in size from 2,000 to 8,000 d.w.t., some were ice strengthened and some were not.

The navigating season as such over the whole area extends from early July until late October when the last of the grain ships leaves Hudson Bay. North of Resolute the Norwegian Bay area is occasionally navigable for about one month of the year to the present class of merchant ships. In the Western Arctic, Point Barrow is the key. The polar ice pack moves against the coast during periods of North Easterly winds and at times Barrow cannot be passed, even in summer months. The Coast Guard icebreaker Camsell based in Victoria operates East of Barrow for about two months of the year from late July to September.

Difficult areas for navigation occur in crossing south of the Byam Martin Island area (both to the southeast and southwest), and at the exit from McClure Strait into the moving pack of the Beaufort Sea. Reports

indicate that crossing from Melville Island to the entrance of Prince of Wales Strait can be very difficult because of ice congestion there caused by weak water currents. In Prince of Wales Strait, one year ice is predominant although some older floes are found in the northern parts of the Strait. On rare occasions there is a small movement of ice southward through the Strait but this is unusual and the amount of ice transported is quite low. Because of the predominance of first-year ice, Prince of Wales Strait would present no difficulty to a super tanker unless the northern entrance of the Strait became plugged solid with multi-year ice.

Should a passage through McClure Strait and into the Beaufort Sea be necessary, a ship could be confronted with the permanent polar pack. Here the proportion of one year to older ice is variable out to about fifty miles from the southern edge of the pack; there old ice predominates and probably averages close to ninety percent of the cover. This pack is in continual but slow motion. The entire mass can move close inshore or drift northward leaving a hundred miles of open water along the coast. This motion is controlled by the pressure systems over the Arctic Basin as a whole, and does not depend very greatly on the local wind conditions between Alaska and Parry Channel. The trend is usually offshore in summer and onshore in fall and early winter. The average thickness of the multi-year ice of the polar pack is about 10-12 feet, not counting pressure ridges.

At the time when the construction of the present fleet of Coast Guard icebreakers was planned, support of year round or extended seasonal traffic in the Arctic was too remote to be considered. The main function

of this class of ship was, and is, to support shipping in the Gulf of St. Lawrence in winter and the Eastern Arctic sealift in summer. The ice conditions encountered in these areas at the respective times are of a different order of severity to those experienced in the Arctic during the winter months. Nevertheless these icebreakers have performed extremely well, particularly in their operations with the Manhattan this spring and last summer. Coast Guard icebreakers also have conducted probes into Makinson Inlet on the east coast of Ellesmere island and other areas throughout the High Arctic, as well as traversing the North West Passage. They have also voyaged as far north as Thule, Greenland, during the month of December, and this year the Louis St. Laurent reached Pond Inlet in company with the Manhattan in May.

The first tentative icebreaking probes relating to mineral extraction began some years ago with the discovery of the Baffin Island ore reserves. The Coast Guard icebreakers John A. MacDonald and d'Iberville conducted break-up and freeze-up studies in Pond Inlet at the northern tip of Baffin Island in order to determine the extent of the possible shipping season in this area. The proposal at that time was to develop a high volume summer shipping operation from Pond Inlet to a transshipment point in the West Greenland coast that was accessible to navigation throughout the year. However, development in the area lapsed pending the evolution of new techniques and policies relating to the Arctic.

To summarize, the experience gained so far in the operations by Canadian ships in the Arctic indicates that:

1. The nature and distribution of Arctic ice is such that it poses a greater obstacle to sea transport the further west one goes. Shipment of resources from the Eastern Arctic would be less of a problem than complete transit of the Passage.

2. The present four month navigation season could be extended for the present class of merchant ships by one to two months in the area east of Resolute.

3. Ships in the Navios class, 50,000 d.w.t. to 60,000 d.w.t. with 14,000 to 17,000 S.H.P., suitably ice strengthened, could operate with icebreaker support of the St. Laurent class from June to November in the area east of Resolute.

4. A 100,000 d.w.t. vessel such as the Manhattan, Plate 3, assisted by an icebreaker of the St. Laurent class, Plate 4, might operate for eight months of the year in the Davis Strait and Baffin Bay.

5. Gulf of St. Lawrence experience is highly relevant to Arctic navigation.

The pursuit of a possible extension to the existing navigation season and the utilization of larger merchant ships would of course require a corresponding expansion of support services, as well as the

creation of new ones. Among these could be included: reconstruction of all existing hydrographic charts on the basis of the most recent soundings; new navigational surface and sonar aids; expanded meteorological services; new communication centres; pollution controls to include equipment specifications, monitoring and enforcement as well as clean-up, and emergency services for air and sea rescue.

We now know that a large well-powered ship of special design can operate over a good part of the Eastern Arctic on a reasonably dependable basis throughout the year. The key word here is "dependability" because investors in oil and gas development become quickly discouraged with a prospect of major storage requirements. Plate 5 shows average ice conditions for December and the range of navigation at the present state of the science is limited to within the area of the broken cover. It will be seen at once by a comparison with Plates 1 and 2 that much of the potential cargo for maritime bulk shipping lies beyond our present limits of certain accomplishment. On the other hand, it is known that for possibly six weeks to two months of the year the same well-powered specially designed ship could penetrate to the far reaches of the Archipelago, as suggested by the nature of the ice cover found in the month of September, as shown on Plate 6, and make the passage on a coast to coast voyage.

It may be deduced on the basis of this kind of evidence that, so far as year round ship operations may be a factor, the immediate future cargo sources are to be found in the Eastern Arctic extending into the Archipelago as far as Resolute. In the long view, most of the Arctic might be considered to be accessible with progress westward scaled to the rate of

progress in technology and experience.

ALTERNATIVE MARINE METHODS FOR TRANSPORTING BULK CARGOES

Outside the Arctic, surface ocean transportation represents at this time the most economic method of transporting bulk cargoes over long distances for long term markets. Economic and political factors have lead to ever increasing sizes of vessels being built for the transport of ores, oil and gas. Tanker sizes alone have increased from 50,000 to 200,000 d.w.t. over a short number of years until now the largest under construction for normal seas is 477,000 d.w.t. "Expert opinion" suggests that the size race will end, and that optimum size will be about 300,000 d.w.t. for normal salt water transport. Economics will, in the end, determine the final situation. Japan has lead the world in low costs, with Sweden, Holland and others also competetive for tanker sizes of about 200,000 tons. The largest such vessel built in Canada to date is in the 42,000 d.w.t. class, however the capacity of existing yards permits building of ships up to approximately 100,000 d.w.t. The U.S.S. Manhattan was rebuilt in American yards to the owners specifications for operation in ice. Such a design and size is within the capability of Canadian designers and yards.

The competition between major shipbuilding countries for tanker construction business has resulted in designs which might be considered to have minimum safety margins in respect of their construction and manoeuvrability. This is not to say that they are marginally safe for

their present mode of operation, rather that they are unsuitable for operation in Arctic waters. The requirements for Arctic operations are now contained in the new Canadian anti-pollution regulations.

Dry bulk cargo vessels, as opposed to oil tankers, are at present operating in the 65,000 d.w.t. to 150,000 d.w.t. class and apparently have not reached the proportions of the oil carrying giants. A combination of world market demand and accessible long term reserves to meet such a demand will no doubt see a further increase in the size of the dry bulk cargo vessel. Canadian yards have built bulk carriers of up to approximately 30,000 d.w.t. Canada has not exported any bulk carriers but has exported the equipment for the handling of bulk cargoes, such as self unloading devices. Clearly, Canadian ship yards have not catered to the large vessel markets of the world to date.

There is an increasing use of OBO, and lately OSO (slurry) bulk carriers to provide revenue-earning capability in both directions of a trade route, and the added flexibility to change contracts and carry alternatively oil or bulk cargo. These vessels are needless to say expensive and when designed for Arctic service will be competitive only in their special environments. In such circumstances there may be less need for flexibility of operation in respect of inner and outer Arctic operation, but a greater need for top quality construction and design for carriage of one or perhaps two kinds of cargo from known resource centres over known northern routes.

The pollution threat from ore-carrying vessels and from liquid gas carrying vessels is substantially less than from oil carriers. For this reason there may be less incentive to design multiple-bulk cargoes carriers (OBO,OSO) for the Arctic in view of the probable higher hull cost due to stricter regulations applicable only to the oil carriers. The dry bulk and liquid gas carriers may get by under less stringent regulations, and, therefore, the economics of combination designs might be less attractive in the North than elsewhere.

A popular method of transporting bulk cargoes now in Arctic coastal trade is by tug and barge. So far, trans-ocean transportation by tug and barges has been minimal and the system as a whole is at present more ideally suited to confined and coastal waterway operations. The advantages of the tug-barge system derives from, or originated, the containerization concept; barges can be left for unloading without tying up the expensive motive power device.

Tug and barge systems are used extensively on the West Coast of Canada for transporting forest products. Canada has built some 82 tugs and 304 barges since 1961. Some of these barges on the west coast are for log carrying and are pioneering in concept and design. Prices range up to $4,000,000. However, the present designs are not considered suitable for northern transport by any means. While barges and tugs have been competitively built in Canada it is considered that the attractivness would be marginal without some form of subsidy. The present subsidy rate is about 22 percent on both tugs and barges.

An Arctic sealift by barge of some 4,000 tons was successfully completed to Rea Point on Melville Island in the summer of 1968. The Learmouth, a 2,000 ton dry cargo barge fitted with an Alexbow, and the Scotty Gall, a 2,000 ton tanker barge were partly towed (through open water) and partly pushed (through ice and restricted channels) by the 4,700 SHP tug Irving Birch. The Scotty Gall was left to winter at Rea Point, and the Irving Birch, pushing the Learmouth, carried out limited tests in ice off the coast of Melville Island. The Learmouth later on was given further testing in the St. Lawrence and Saguenay Rivers prior to being holed by ice and sinking off Byan Martin Island when on a voyage into the Arctic in 1969. The results from these tests are as yet inconclusive as to the merits of the barge or Alexbow principles of movement in ice-infested waters.

There have been proposals by responsible firms to proceed with construction of a specialized icebreaker-bulk carrier that could operate independently of icebreaker support as an alternative method of northern supply and bulk cargo transportation. A disadvantage to this alternative is that for most of its voyage it would be outside the Arctic waters which would not require the maximum protection and power with which it had been equipped, and which contributed substantially to its capital cost.

An interesting alternative for bulk shipping proposed by one firm is based on the use of 170,000 d.w.t. to 300,000 d.w.t. submarine tankers. The advantage of this concept would be that only the receiving and unloading points on the route would have to be ice free. It would

be uneconomical to use the submarine tanker for the full voyage to the refineries, and an intermediate transshipment terminal, say in Newfoundland, would be essential to ensure year round access by conventional tankers. In forecasting costs for nuclear submarine supertankers, which do not presently exist on a commercial basis, there is considerable possibility of actual figures deviating from forecast.

In summary, there are difficulties in forecasting costs for the operation of large bulk carriers in the Arctic, in spite of the existence and operation of similar sizes of ships in more temperate waters. A factor of between five to ten times normal cost is a common multiplier for Arctic activity of any kind, a good part being due to the cost of insurance. One factor is clear - bulk transporter designs for the Canadian Arctic will be different, with new regulations and environmental conditions causing a complete re-examination of the present day criteria.

INDUSTRIAL DEVELOPMENT IN CANADA AS A RESULT OF ARCTIC TRANSPORTATION ACTIVITY

Having reviewed some of the possible systems for bulk shipping, some comment would be appropriate on the additional opportunities for maritime oriented secondary manufacturing industries in Canada which could result directly from development of the Arctic, in particular, the new markets for made-in-Canada water transportation equipment.

It is an easy matter to become caught up in the exploration and exploitation activities themselves and consider only the sought-after

resource as the only benefit to Canada. However, the equipment which is needed to explore and eventually transport the materials out of the North represents a real challenge for those industries in Canada with the technical skills and the enterprise to produce sophisticated hardware, including drilling platforms, bulk carriers, tankers, icebreakers, barges, tugs, submersibles and marine equipment. The processing of ores, oil or other resource materials in Canada also means a market for Canadian machinery and design skills. We are concerned in this instance with transportation equipment, but the principle could be applied across-the-board to manufactured products for the North in general.

The Canadian shipbuilding industry has the technical capability, materials, and available capacity to produce ships for Arctic use. Historically, it has been able to supply most of Canada's domestic needs for ships and marine platforms, from warships to self-unloading bulk carriers, and from fishing vessels to scientific and exploration water vehicles. Since 1966, when government adopted procurement policies which encouraged rationalization of the industry, manufacturing units have on the whole become more competent and competitive.

The success of previous years in satisfying domestic shipping needs has resulted in a currently low domestic demand for ships, particularly so in the Great Lakes area where the Canadian fleet of bulk carriers became prime movers of both the Canadian and the international trade. The Arctic may well represent a potential new market frontier for Canadian

shipbuilders. The degree to which Canadian yards are able to build for our Arctic is dependent on two factors. Firstly, there is the matter of government policy respecting the coastal trade and the feasibility of a new Canadian deep sea fleet. Reports on these two policy areas are expected to be in the hands of government in the near future. Depending on the outcome of the studies, use of Canadian built vessels will be rendered more, or less, attractive to shipping companies. The second factor relates to the enterprise and innovative skills of the Canadian shipbuilder (and for a consortium of Canadian marine equipment manufacturers including shipbuilders).

The Department of Industry, Trade and Commerce has financial assistance programs which share the risk of new projects with the developer company. Some programs involve grants of up to 50 percent of costs, and cover a new development from conception through to prototype construction and even to environmental testing. These programs have been successful for the most part in encouraging new products to be built for normal commercial risk markets. It remains to be seen whether the risk and cost levels to be encountered in the Arctic can be accommodated by the available programs.

It may be necessary that the shipyards combine in joint projects with prospective shipping companies and even with the prime resource developers in order to obtain viable risk carrying corporate units to develop and test new water transport systems. In the case of the "Manhattan" experiment, it was of course Humble Oil and other resource developers who

took the risk and the initiative. It is to be hoped that this kind of work could be undertaken in the future by Canadian firms as well, and as joint projects if necessary.

A number of alternative proposals for bulk carriers are in the evaluation stages by Canadian and U.S. firms and were discussed in a previous section. We expect there will be competing proposals among these alternatives, all based on irrefutable economic projections, and that perhaps several different projects will move forward to prototype testing in the North. From the standpoint of industrial development and the resources the government may devote to such work, the following government guidelines, applicable to industrial assistance, should be kept in view:

1. Designs that hold hope of multiple unit sales are preferred to designs with only a low volume potential. The research and development investment should be spread over multiple units for maximum return on investment. Naturally, high volume also lowers unit cost. Therefore, if there is a possibility that several resource centres in the North could be served by the same vessel design, then this design would be favoured over single-service designs in order to raise unit volume.

2. The market outside the Canadian North should also be analyzed when a design project is in its early stages; there is always potential for export of

a successful new ship design. U.S. firms operating in the Canadian North and in Alaskan territories are prospects for superior new vessel systems. So are the Russians and the Scandinavians.

As an example, suppose an ore carrying capacity is required to serve Baffin Island mines. Selection of the optimum vessel or transport system should include thought as to what other resource-haul markets might also be served. Slight or major design changes might be accommodated at this stage that would broaden the market for the vessels and make it a profitable product by itself.

Two sectors of the Canadian marine industry have already had some success in export selling; these are the shipboard components sector and the oceanology sector. Exports for these sectors total approximately $40 million per year. Some companies in these sectors already have begun market development work on Arctic products, and certain products are in design stages under assistance programs with the Department of Industry, Trade and Commerce.

It would be an oversight not to mention the marine design competance which is resident in Canada. Canadian consultants have designed many icebreakers, among them the St. Laurent which was so essential to the

Manhattan on her recent voyage. Canadian marine consulting expertise has been successful with technology abroad; for example, the largest selling mass-produced new vessel in the world's merchant marine today is a Canadian design ("Freedom" class, 96 "copies" at last count). There are, therefore, the necessary elements in this country to serve the expanding North with Canadian made ships and shipping systems.

While the Canadian shipbuilding industry itself has not been an exporter of ships before, it has been moving closer and closer to export capability in recent years. A new domestic market is opening in the North. The market may well be expanded to an international one if the right initiatives are taken by the Canadian industry. Stringent new Arctic regulations for design and construction materials will tend to put all shipbuilding countries on an equal footing for this business. Canadian shipyards and related supplier industries should aggressively pursue this opportunity.

ROLE OF GOVERNMENT

At this stage we might consider the role of government in the evolution of maritime bulk shipping in the North. Notwithstanding the fact that much has already been accomplished as a result of the many public and private activities in the North, the full range of development opportunity remains practically untouched and unencumbered. There is, therefore, ample scope for government to moderate the on-going action and reduce the forces of instability inherent in a mining-based economy.

There remains every opportunity to avoid many of the alleged sins and omissions of earlier similar ventures of a more modest scale.

Maritime bulk shipping, although an element of marine transportation, can expect to be conditioned in its operations by a wide range of government objectives and programs other than those specifically coming under the heading of transportation. Indeed, intervention by government under a transportation objective may more often than not be a response to initiatives taken in the private sector or elsewhere in the public sector. The implication here is that bulk shipping, like any other industrial activity in the North, can expect an especially hard scrutiny from government to see that it presents not only the most beneficial alternative from the standpoint of transportation, but to ensure that, by its actions and presence, it upholds the basic fact that the Northern areas we are concerned with are indeed Canadian, and that the resources are not to be rooted out in a crude manner that will produce undesirable side effects on the environment and the welfare of the indigenous population.

The government, therefore, will have a significant regulatory function. Within this context we must look at several different types of regulation: technical regulation to deal with the requirements of ships and related equipment to perform efficiently and safely under the demanding geographical and meteorological conditions, as well as the basic skills required of the men employing those assets; economic regulation to encourage a maximum net return from public and private investment in Arctic transportation; and finally, political regulation, which will have to do

with the definition of such matters as the limits of coastal waters, the protection of sovereignty of those waters, and the conditions under which the participation of foreign-flag vessels in the transportation of bulk commodities from the Arctic should be permitted.

In the area of technical regulations, whether the regulations apply to vessels themselves or the ancillary facilities serving the vessels, the prime consideration will have to be given to the safety of human life. In this area, there is plenty of scope for imaginative thinking. For example, an ordinary lifeboat would not be much help to the crew of a ship sinking in a large icefield. Consideration must also be given to the security of the vessel, its cargo, and to the prevention of damage to the ecology. Legislation already enacted along with that recently introduced in parliament to protect against pollution is convincing evidence of the work being done towards having the necessary regulatory process ready for application when needed. Technical regulations can, of course, have an influence on the economic position of water transportation in the North, in fact, an influence much greater than normal because of the more rigorous demands on factors of safety and performance.

The Ministry of Transport is firmly committed to the principle of "user pay" in respect to the way and terminal facilities provided by government. There is little doubt that this principle will be applicable in northern water transportation activities and will be an important element of so-called economic regulation. Of similar fundamental importance is the

question of possible new regulations respecting the Canadian share in the ownership of vessels operating in the Arctic in bulk shipping trades that must rely to a very large extent on foreign markets. Similarly, the recommendations that will be developed from the enquiry into the Canadian coasting trades may be of such consequence to the economics of Northern operations that the timing of participation by Canadian fleet owners could be advanced or retarded by several years.

Water transportation is often a least-cost alternative, and this favourable position appears to be similarly the situation with respect to transportation in the North, since all modes must contend with conditions that increase costs of all activities. Even so, it is obvious that water transportation costs are still too high to encourage a flood of private investment in development projects that include large outlays for transportation services. Therefore, there will have to be in many cases some incentive, other than resource development. In other words, a most important part of the regulating influence of government will depend on objectives that are essentially of a political nature. Additional icebreaker services, for example, may well have a purpose related initially to defence in circumstances not unlike those that generated the existing Northern re-supply program of the Ministry of Transport.

CONCLUSIONS

In this paper an attempt has been made to show that a dependable major maritime bulk shipping operation to the outer reaches of the North

is still some years away, awaiting further advances in technology and experience. On the other hand, a large part of the Eastern Arctic is now accessible during an expanding season of navigation to ice strengthened and well powered ships, and this region appears to be on the threshold of an accelerated rate of expansion in bulk shipping activity. However, the development of resources in those regions that come within the range of the present operating capabilities will continue to carry a big price tag for transportation. Accordingly, there will be a strong demand for government support of private initiatives.

This is not intended to be an argument in support of inaction by the shipping industry; on the contrary, there is a real opportunity for that industry and its suppliers to participate actively in the evolution of an effective Northern water transportation system. The starting point may well be the existing Arctic re-supply and sealift operations, which like many other Northern activities is growing rapidly.

The range of options will be influenced no doubt by government decisions that will follow the completion of reports on the Coastal Trade and the study on the feasibility of re-establishing a Canadian Flag fleet. Nevertheless, one now can foresee opportunities and a need for joint action by government and by industry through consultation, shared research on ship design and operations methods, and quite possibly, in a follow up with experimental voyages and probes to potential resource development centres. Canada traditionally has looked to world shipping for the carriage of

export and import cargoes. Canadian shipping interests have long insisted on a piece of the action. It is offered as a basis for discussion that the development of the North and of the maritime bulk shipping needs of the area in particular provide a real opportunity for such participation.

TABLE 1

ESTIMATE OF KNOWN AND POTENTIAL RESERVES, PRODUCTION

AND

POTENTIAL AVAILABLE ANNUAL CARGO (1)

COMMODITY	LOCATION	KNOWN RESERVES	POTENTIAL RESERVES	LIFE OF RESERVES	ESTIMATED PRODUCTION PER YEAR	POTENTIAL CARGO PER YEAR (TONNAGE)
Oil	Arctic Coastal Plain, Mackenzie Delta and Queen Elizabeth Islands	–	43.45 billion bbls.	–	40 million bbls. (1972) 288 million bbls. (1979)	6.9 million tons 50 million tons
Gas		–	260.7 trillion $ft.^3$	–	100 billion $ft.^3$	2 million tons (liquified)
Iron	Baffin Island	130 million tons (ore)	–	30 years	4 million tons (ore)	4 million tons
Copper	Coppermine	4 million tons	–	10 years	20,000 tons (concentrate)	20,000 tons
Lead	Strathcona Sound	12 million tons (ore)	–	14 years	60,000 tons (concentrate)	60,000 tons

(1) A Forecast of Ship Requirements by Developers of Non-Renewable Resources in Arctic Canada prepared by the Oil and Mineral Division Northern Economic Development Branch Department of Indian Affairs and Northern Development.

TABLE 2

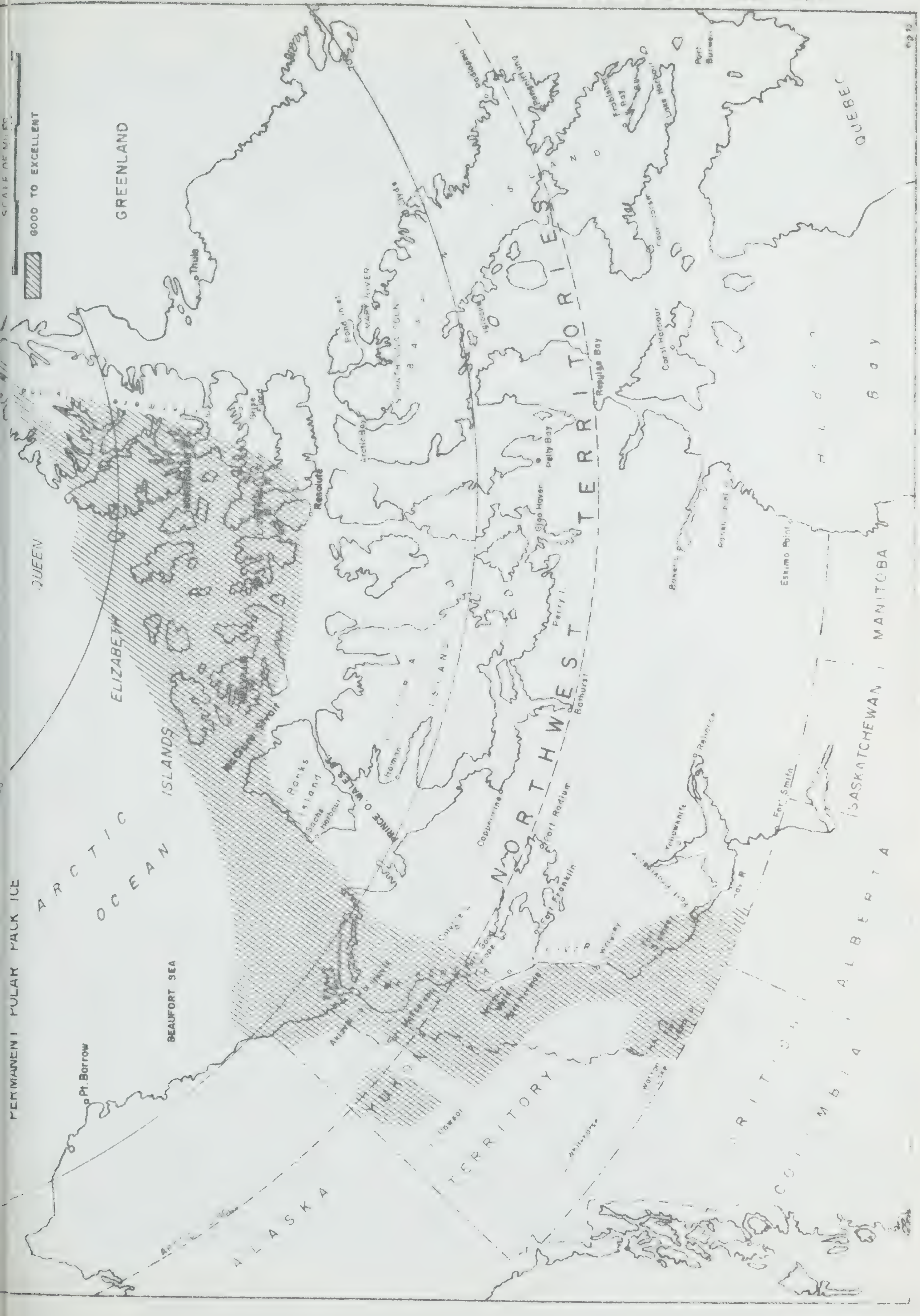
POTENTIAL RESERVES OF CRUDE OIL AND NATURAL GAS IN CANADA

RECOVERABLE BY CONVENTIONAL METHODS (1)

POTENTIAL HYDROCARBON AREAS OF CANADA	AREA SQ.MI.	VOLUME OF SEDIMENTS CU. MI.	OIL YIELD BBLS./CU. MI.	POTENTIAL CRUDE OIL RESERVES, MMBBLS.	POTENTIAL RAW GAS* RESERVES, TCF
1. Western Canadian Sedimentary Basin	800,000	1,000,000	45,000	45,000	270.0
2. Arctic Islands, Coastal Plain and Foxe Basin	452,200	790,000	55,000	43,450	260.7
3. Eastern Canada Offshore	246,000	450,000	55,000	24,750	149.9
4. Gulf of St. Lawrence	94,000	145,000	15,000	2,175	10.9
5. Southern Ontario	26,000	6,500	20,000	130	2.1
6. Hudson Bay	365,000	145,000	20,000	2,900	17.4
7. West Coast	48,000	45,000	40,000	1,800	10.8
8. British Columbia Interior	46,000	60,000	10,000	600	3.0
		2,641,500		120,805	724.8

* Total Potential Gas Reserves were calculated on the basis of an average of 6,000 feet of recoverable gas being discovered for each barrel of Potential Oil Reserves.

(1) Canadian Petroleum Association, 1969.



PROSPECTIVE OIL AND GAS REGIONS

PLATE No. 1


SCALE OF MILES
GOOD TO EXCELLENT
GREENLAND
Thule
QUEEN ELIZABETH ISLANDS
NORWEGIAN
Resolute
MELVILLE
McClure Strait
Banks Island
Sachs Harbour
PRINCE OF WALES ST.
PERMANENT POLAR PACK ICE
ARCTIC OCEAN
BEAUFORT SEA
Pt. Barrow
ALASKA
YUKON TERRITORY
Aklavik
Inuvik
Fort McPherson
Norman Wells
Fort Norman
Fort Good Hope
Colville
Wrigley
Fort Simpson
Fort Franklin
Fort Providence
Coppermine
NORTHWEST TERRITORIES
Arctic Bay
Pelly Bay
Repulse Bay
Gjoa Haven
Coral Harbour
Baker Lake
Frobisher Bay
Lake Harbour
Cape Dorset
Fort Burwell
Fort Smith
HUDSON BAY
QUEBEC
MANITOBA
SASKATCHEWAN
ALBERTA
BRITISH COLUMBIA

OPENING THE NORTHWEST PASSAGE – U.S.S. MANHATTAN ASSISTED BY C.C.G.S JOHN A. MACDONALD

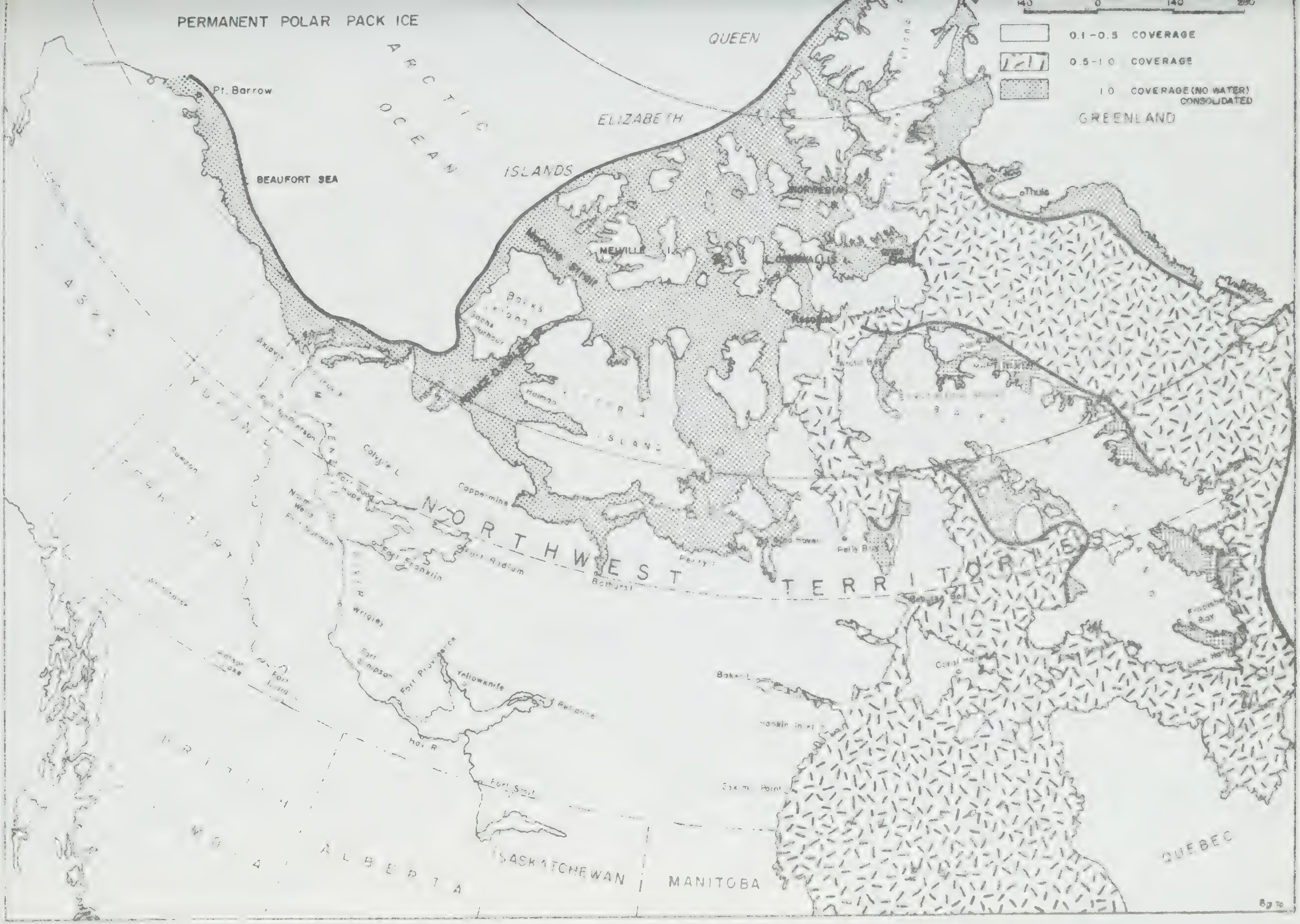
U.S.S. MANHATTAN		C.C.G.S. JOHN A. MACDONALD	
LENGTH	940 FT.	LENGTH	315 FT.
BREADTH	132 FT.	BREADTH	70 FT.
DRAFT	53 FT.	DRAFT	28 FT.
POWER	43,000 S.H.P	POWER	15,000 S.H.P.
DWT	135,000 TONS	GROSS TONS	6,186 TONS
2 PROPELLER AND 2 RUDDER		TRIPLE PROPELLER	

PLATE No. 3

C.C.G.S. LOUIS S. ST. LAURENT – ON TRIALS – SPRING 1970

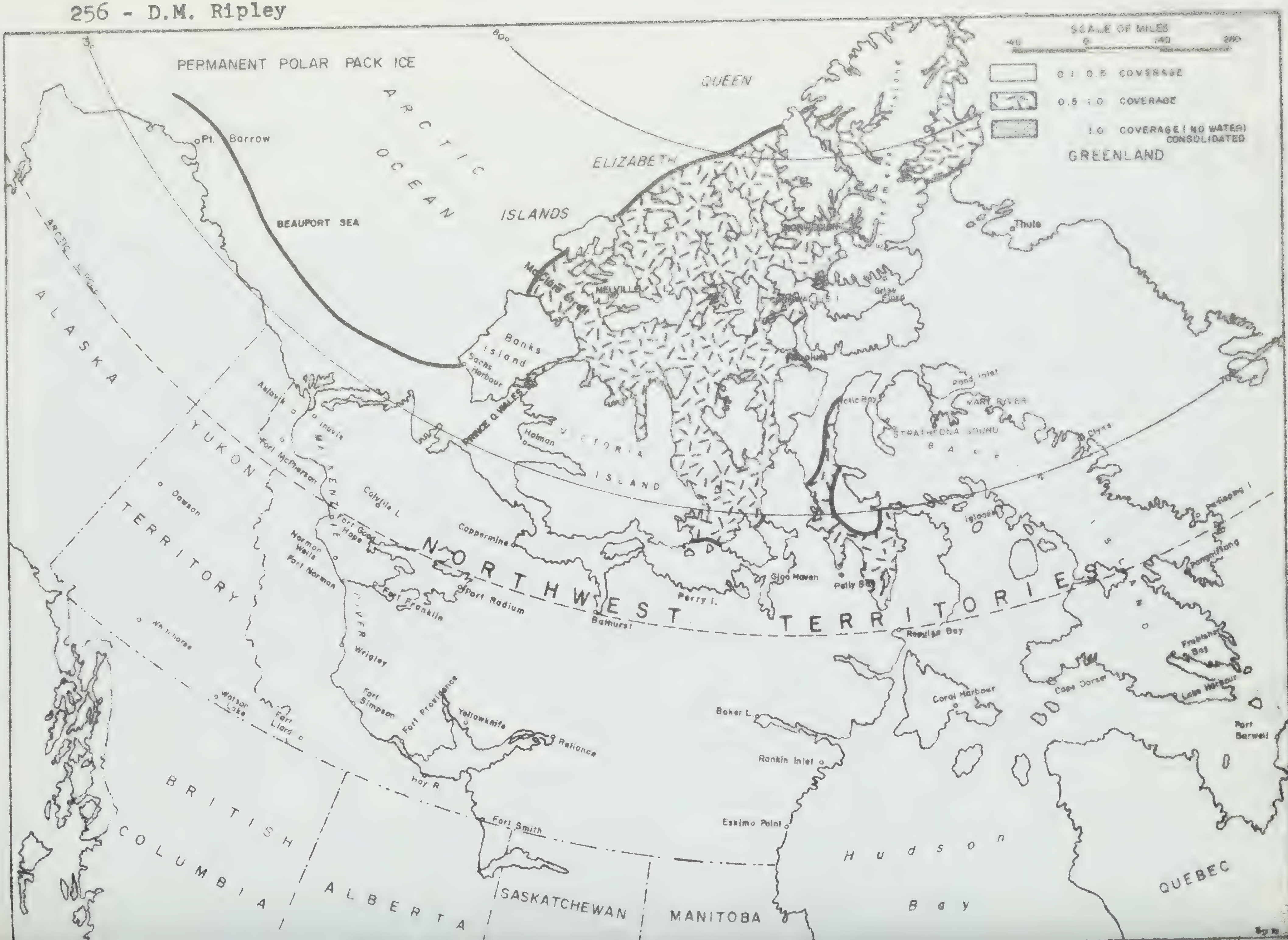
LENGTH	367 FT.
BREADTH	80 FT.
DRAFT	30 FT.
GROSS WEIGHT	10,907 TONS
POWER	24,000 S.H.P.
TRIPLE PROPELLER	

PLATE No. 4



AVERAGE CONCENTRATION OF ICE CONDITIONS IN DECEMBER

PLATE No. 5


SCALE OF MILES
40
0
140
280
0.1-0.5 COVERAGE
0.5-1.0 COVERAGE
1.0 COVERAGE (NO WATER) CONSOLIDATED
PERMANENT POLAR PACK ICE
ARCTIC OCEAN
BEAUFORT SEA
QUEEN ELIZABETH ISLANDS
GREENLAND
Thule
Pt. Barrow
ALASKA
ARCTIC CIRCLE
Banks Island
Sachs Harbour
MELVILLE
PRINCE OF WALES STR.
Holman
VICTORIA ISLAND
Grise Fiord
Pond Inlet
MARY RIVER
STRATHCONA SOUND
Clyde
Igloolik
Pangnirtung
Frobisher Bay
Lake Harbour
Cape Dorset
Coral Harbour
Port Burwell
QUEBEC
Hudson Bay
Repulse Bay
Pelly Bay
Gjoa Haven
Perry I.
Bathurst
NORTHWEST TERRITORIES
Coppermine
Port Radium
Fort Franklin
Colville L.
Fort Good Hope
Norman Wells
Fort Norman
Aklavik
Inuvik
Fort McPherson
YUKON TERRITORY
Dawson
Whitehorse
Watson Lake
Fort Liard
Wrigley
Fort Simpson
Fort Providence
Yellowknife
Reliance
Hay R.
Fort Smith
Baker L.
Rankin Inlet
Eskimo Point
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA

PLATE

VOLUME 3

SECTION 5 - AIR CARRIER OPERATIONS

CHAIRMAN: D. H. Watson

PANELISTS: J. Courtney

K. Peiffer

R. A. Morrison

M. Ward

"Objectives must reflect the needs of native northerners".

Jean Chrétien

Air Transport in the Canadian North

BY: MR. J. COURTNEY
Research Economist, Research Branch, Canadian Transport Commission

Commercial aviation is the most ubiquitous mode of transport in the North today. It is helping to change this area and is itself changing as a result. However, although aviation technology has increased both capability and capacity, the air system is still 'underdeveloped' serving a very low population density over long stage-lengths with a rapidly fluctuating pattern of demand. Equipment modernization and specialization may be necessary to the long-run efficiency of the carriers, but there will still be a role for the small piston aircraft for vital local community services such as medical evacuation for some time to come.

This paper will examine the current structure of the commercial aviation industry in the Northwest Territories. Special attention will be given to levels of community service (and the west-east air link) as well as the problem of heavy airfreighting in terms of achieving the basic national transportation goal which is "an adequate, economic and efficient transportation system, making use of all available modes of transportation at the lowest total cost". The objective of this paper is to provide the essential facts of the situation rather than a set of answers.

Most people view Northern air transport as being a bleak and isolated existence from which a few rugged individuals eke out a living as bush pilots. This tradition remains with us.

The current 'rush' for oil in the High Arctic has spurred the introduction of new air technology such as the Hercules. Carriers are in the market for replacements for their piston airfreighters.

There is an increasing emphasis on integration - the integration of passengers and freight pallets in Boeing 737 - 200C; or, the integration of ground and air transport. The interface between modes, however, presents some problems[1] as does the interface between types of air service.

The commercial air transport system of this area evolved from bush operations to Boeing 737 jet service. There are three main entry routes to this region each with its associated 'gateway' centre (Figure 1).

1. Nordair flies from Montreal to Frobisher in the Eastern Arctic and on to Resolute Bay in the Central Arctic.

2. Transair services the Keewatin settlements from Churchill and is licensed to operate to Yellowknife in the west and as far as Coral Harbour to the east.

3. PWA from Edmonton links Hay River, Fort Smith, Yellowknife, Norman Wells and Inuvik in the Mackenzie District and services Cambridge Bay and Resolute as well.

Feeder lines emanate outwards from major centres. These important links are maintained by a number of carriers scattered throughout the 1.5 million square miles of the North. They often complement the 'entry' activity of the three regional carriers noted above.

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1 E.H. Kolcum, "Air Cargo Seen Stumbling on the Ground", Aviation Week and Space Technology, September 28, 1970, p.27.

There are few centres not possessing regular air service. Lac La Matre, Belcher Islands and Port Burwell are the only settlements with a population over 75 that are not serviced on a scheduled basis by air (or ground) transport.

There is a discernable hierarchy of service centres with associated air routes patterns. Main (access) line daily jet service links major centres to southern 'gateway' centres (DC-3 and jet prop in the Keewatin). Feeder prop and turbo-prop service branches out from the main northern settlements with service 2-3 times per week. Secondary feeders - again, usually from major centres - provide weekly or monthly service to more isolated communities with limited landing facilities. Finally, there are charter operators who range throughout the North.

II

The Research Branch, Canadian Transport Commission recently completed an air traffic survey of all fixed-and-rotary-winged commercial operations into and/or within the Yukon and Northwest Territories. The study period was April, 1968 to September, 1969. Sixty-three carriers were visited, and 100,000 data records were collected. The results have been published as Northern Air Transport Study, Volume 1, Traffic Survey. Four series of summary tables have been produced.

TABLE 1 SUMMARY TABLES

Variable	Tables 1-2 Link Flows	Tables 3-6 Areas Served	Tables 7-8 Trip Purpose	Tables 9-10 Aircraft Use
Aircraft Type	Fixed-Wing	'Shuttle', Helicopter	Fixed-Wing, 'Shuttle', Helicopter	89
Areal Unit	Points and Zones	Point/zone	Total System	Total System
Activity Measure	Freight (lbs.) Passengers Flights	Freight (lbs.) Passengers Revenue Hours	Ton-miles Passenger-Miles	Ton-Miles Passenger-Miles

There is a definite market dominance by the three regionals (PWA, Transair, Nordair) which account for 80% of all ton-and-passenger-miles flown (Figure 2). However, they control only about 50% of the Group A equipment (18,500 pounds and over). The top ten carriers have not changed appreciably during 1968/69 in ranking. There is a decided ordering of airfreighting (Figure 3), but five carriers have similar passenger-mile totals (Figure 4), although their fleet compositions are different.

Passenger-mile Group A utilization increased 24% between Summer 1968 and 1969 (Figure 5). Summer is defined here as the period April through September. The most striking change is the wholesale introduction of the Boeing 737 to replace the DC-6B, DC-4 and Super Constellation on main routes.

Heavy airfreighting increased dramatically and the Hercules accounted for almost one-third of all ton-miles flown (Figure 6). There is a strong correlation between size of craft and the rate of ton-mile increase.

Group B performance has not been so dramatic. However, the DHC series has retained its dominance, and the Twin Otter has achieved a certain degree of market penetration (Figure 7).

Fixed-wing trip purpose reflects the dominance of a few types of operation. Scheduled passenger-miles swamp all others, and showed a healthy increase between 1968 and 1969 (Figure 8). Oil exploration support by Hercules aircraft overtook scheduled ton-miles in 1969 (Figure 9).

Helicopters are coming into their own for servicing areas out of the main distribution points. Seventy-five per cent of the helicopters used are Bell Jet-Rangers. Helicopters while limited usually to summer work are being used increasingly during the dead of winter for air evacuations and oil work.

In terms of revenue hours, helicopter use has a strong resource development orientation (Figure 10). Mining exploration has been fairly constant over the last two years, but oil exploration has been changeable - particularly, in the Islands.

These results point out the quantum jump resulting from the introduction of newer and larger aircraft to the problem of Arctic supply during the boom period of the late sixties. However, it must be remembered that one carrier (PWA) accounted for much of this change. The local service carriers nevertheless underwent rapid growth during this period.

III

April 1, 1970 the Government of the Northwest Territories assumed responsibility for administering the Eastern Arctic from Frobisher Bay. As a result, there is a need for the consideration of the requirement for a lateral air link (Yellowknife-Churchill-Frobisher Bay) that would, in effect, depart radically from the traditional north-south orientation of main line service (see Figure 1).

There appear to be four basic options available each with an associated fare structure. These options are diagrammed in Figure 11 indicating the approximate times involved for each. The Territorial Government with its relatively small staff seeks to minimize travel time at minimum cost. In these circumstances, the solution requires a reduction of travel time. Each of these options has its own particular characteristics.

1. The "southern route" involves four days of travel for one day of business.

2. Poor connections between PWA and Nordair make this route CURRENTLY unacceptable. However, if this could be overcome, the longest way around could become the shortest way home.

3. A small (6-10 seat), fast (250 m.p.h.+) craft could be used by a carrier on a contract basis.

4. The Boeing 737 jet would provide high capacity service, but at higher costs owing to the low level of potential demand.

Demand figures supplied by the Territorial Government[1] and the ATA/RAC costing formula[2] were used to derive RELATIVE ORDER OF MAGNITUDE COST ESTIMATES for two new aircraft types on the Yellowknife-Churchill-Frobisher Bay route[3]. Although Northern fuel and other costs were used, these estimates are on the CONSERVATIVE side.

Fare levels would appear not to increase appreciably for the MU-2G, but jet service is much more expensive (Figure 12). It must be remembered that the start-up costs for the MU-2G or the HS-125 service would be quite high, and that if the level of demand increased appreciably they would be capacity constrained. On the other hand, the Boeing 737 is already in service, but the amount of initial excess capacity would result in exorbitant costs. This latter option is a more long-run solution to such a problem.

IV

While each centre or area in the North has a particular level of service at any one point in time, its economic function may change over time, as well as the level of service afforded it. The resource development scenario in Figure 13 depicts one possibility for such an evolutionary process.

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1 Twice-weekly service for an initial 846 trips Yellowknife-Churchill and 502 Churchill-Frobisher Bay. Totals for 1969 were 195 and 100 respectively.

2 Air Transport Association of America: Standard Method of Estimating Comparative Direct Operating Costs of Turbine Powered Transport Airplanes. December 1967, and Research Analysis Corporation, Cost Analysis of Supersonic Transport.

3 For these aircraft, the fare is computed as the total operating cost plus a 10% profit margin.

Between exploration and preliminary full-scale development, a number of activities occur: surveys, ground party work, the establishment of a base camp, and, finally, the placement of a development site. Associated with each are particular types of aircraft offering different levels of service. The time is fixed here at ten years, but areas may undergo several of the stages of activity simultaneously or with lags of several years.

Airfreighting has undergone a rapid expansion recently due to resource development work - particularly, oil exploration. While the volumes are still small relative to the rest of Canada, the quantities are vital to the economy of the North. Indeed, it may well be that "most of the economic story is in (the) connecting links to the outside"[1].

Approximately twelve thousand tons of freight were airlifted into the North during 1969 (Figure 14). Over one-third of this entered from Edmonton-Calgary. Montreal and Churchill were of lesser importance, while the relatively small volume from northern British Columbia probably reflects competition with trucking on the Alaska Highway and by railway.

Once this tonnage has entered the North, it is distributed from a number of key hubs (Figure 15). Yellowknife is the most important supplying the Arctic Islands oil sites, Mackenzie Valley settlements, and the DEW line resupply points of Cambridge Bay and Cape Perry.

Churchill also supplies DEW line sites. Frobisher, Resolute Bay, Whitehorse and Inuvik have localized or through-flow distribution patterns. However, there is heavy traffic to the JAWS stations out of Resolute.

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1 T.W. Schultz, "Some Economic Aspects of the Northland", in Canadian Economic Problems and Policies, L.H. Officer and L.P. Smith, ed. 1970, p. 353.

V

Commercial aviation in the Northwest Territories is in a state of transition. At this juncture, it is necessary to take a really hard look at the capital funding of aircraft technology. Are the substantial gains in sales for the last few years the total picture? How much capacity will be needed in the 1970's? There is a very real need for better information flows to carrier management, so as to achieve a balancing of new equipment expenditures with assured levels of demand. Adequate levels of transport service must be both efficient and economical.

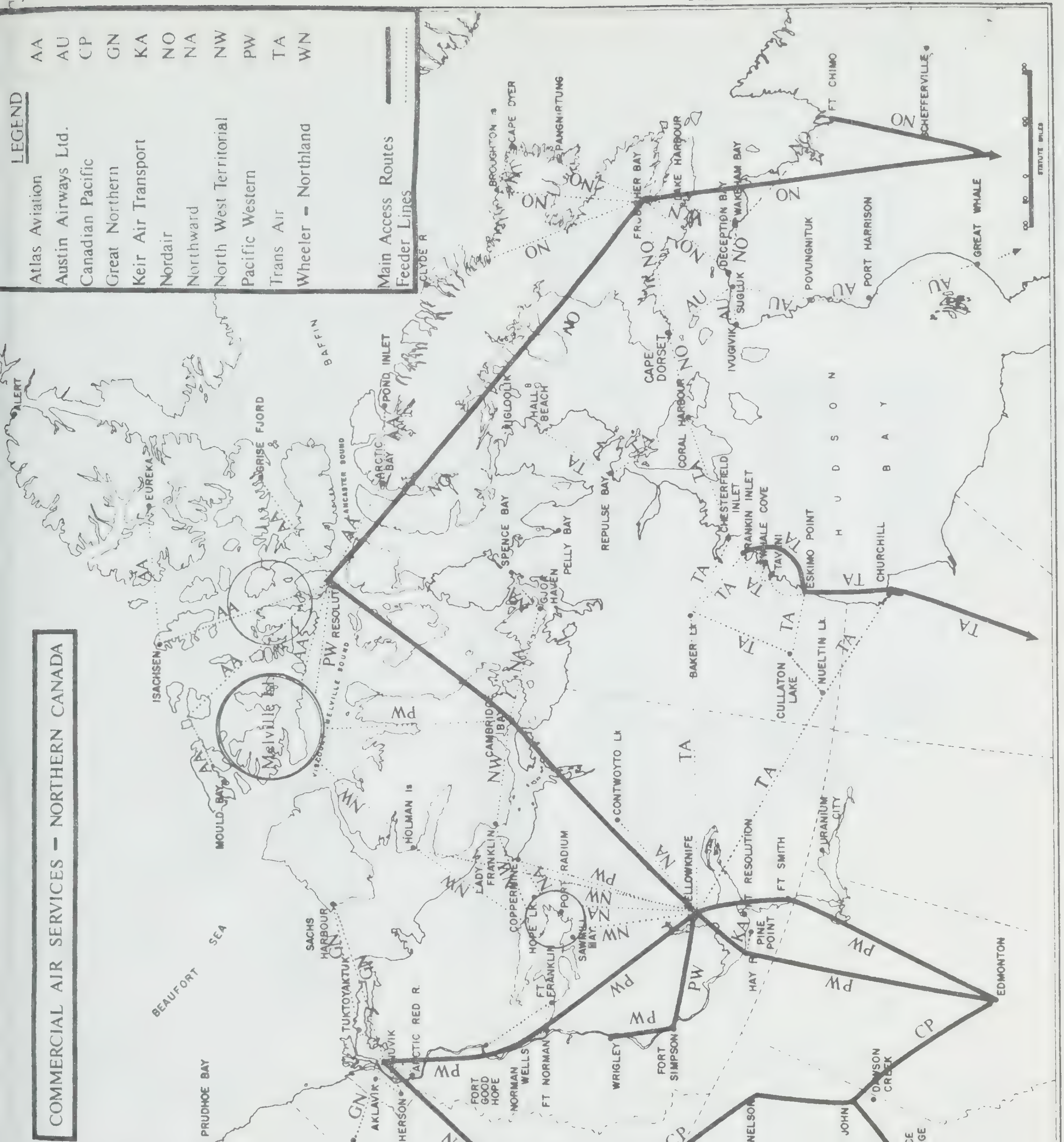


FIG. 1 COMMERCIAL AIR SERVICES – NORTHERN CANADA

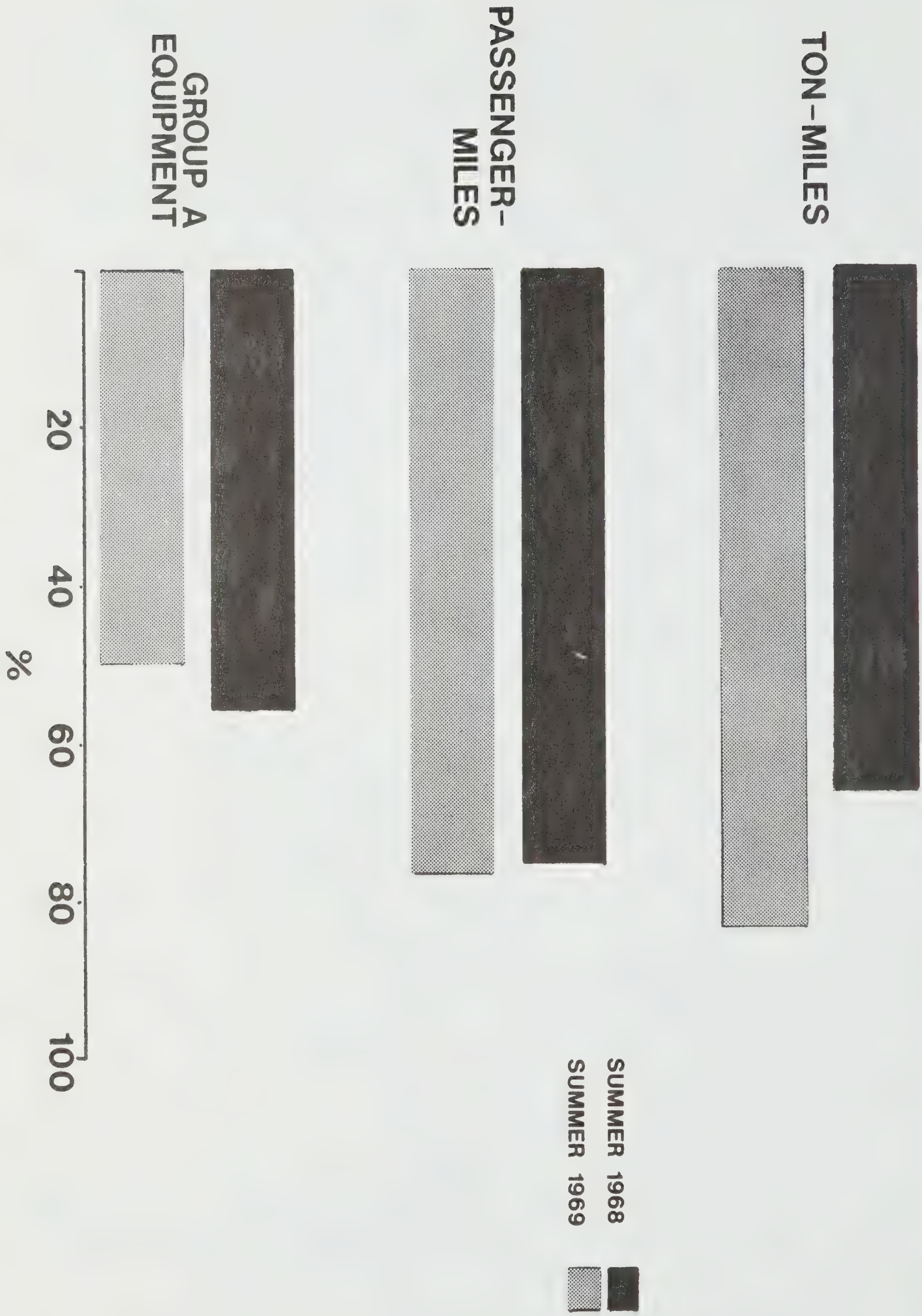


FIG. 2 MARKET DOMINANCE
PWA, NORDAIR, & TRANSAIR

FIG. 3 **THE TOP TEN**

CARRIER TON-MILES

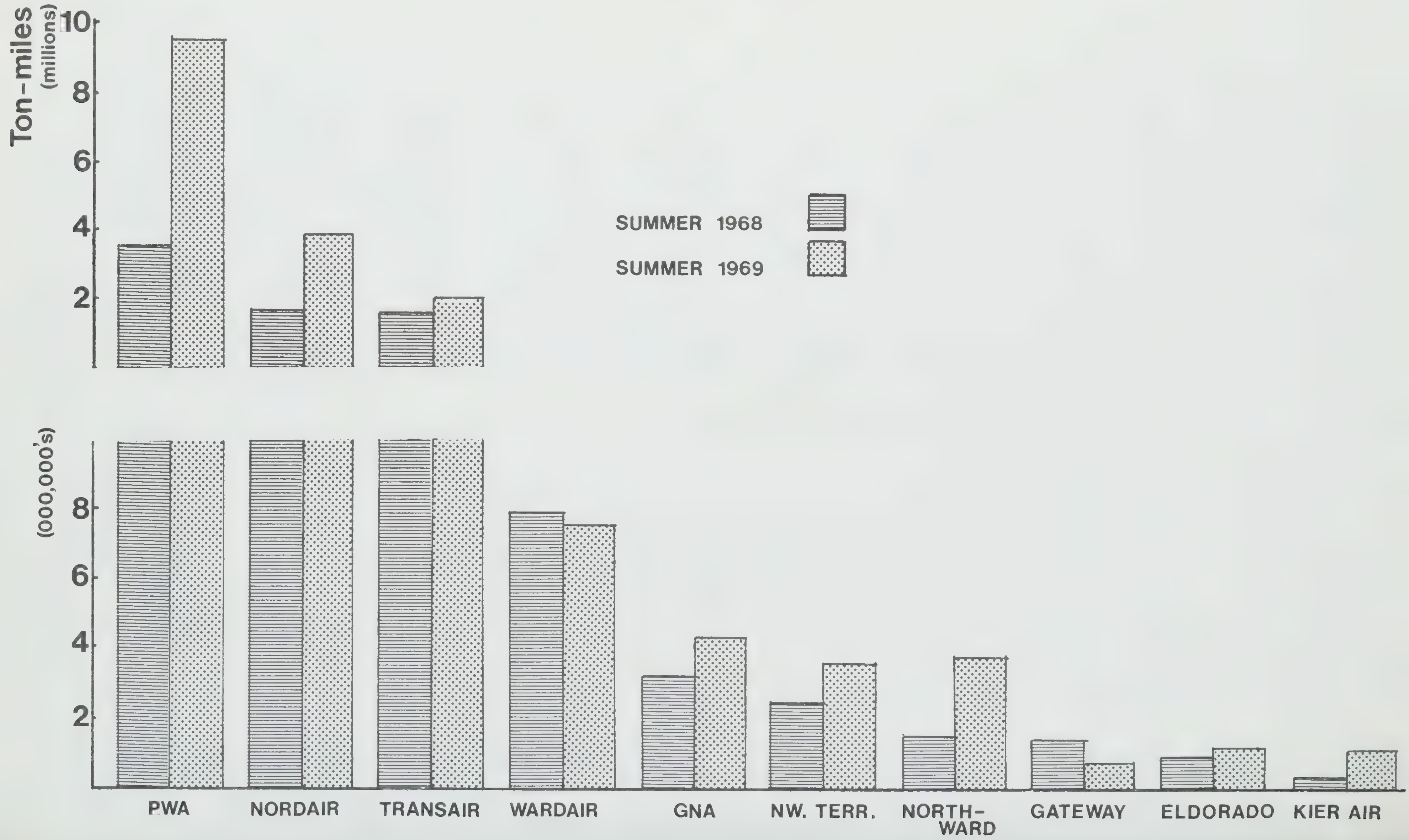


FIG.4 THE TOP TEN
CARRIER PASSENGER-MILES

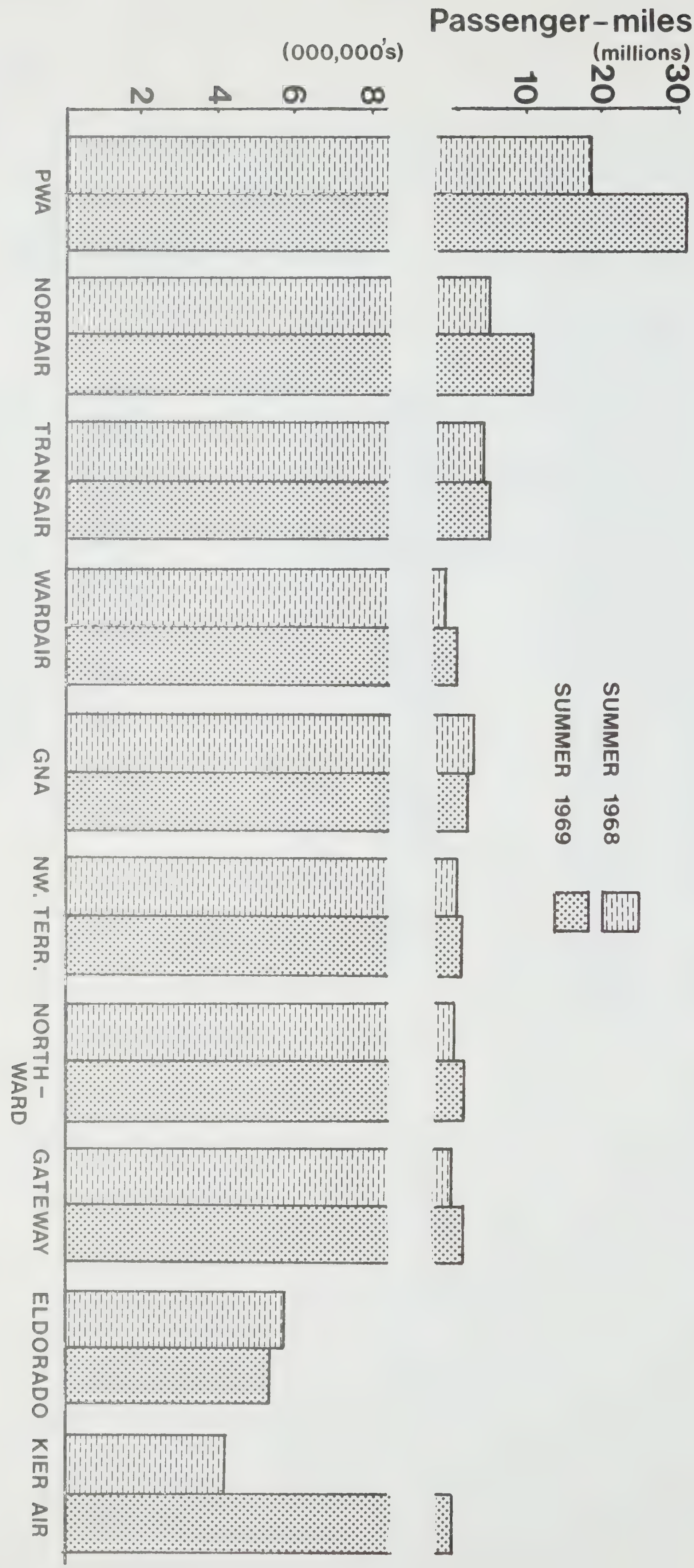
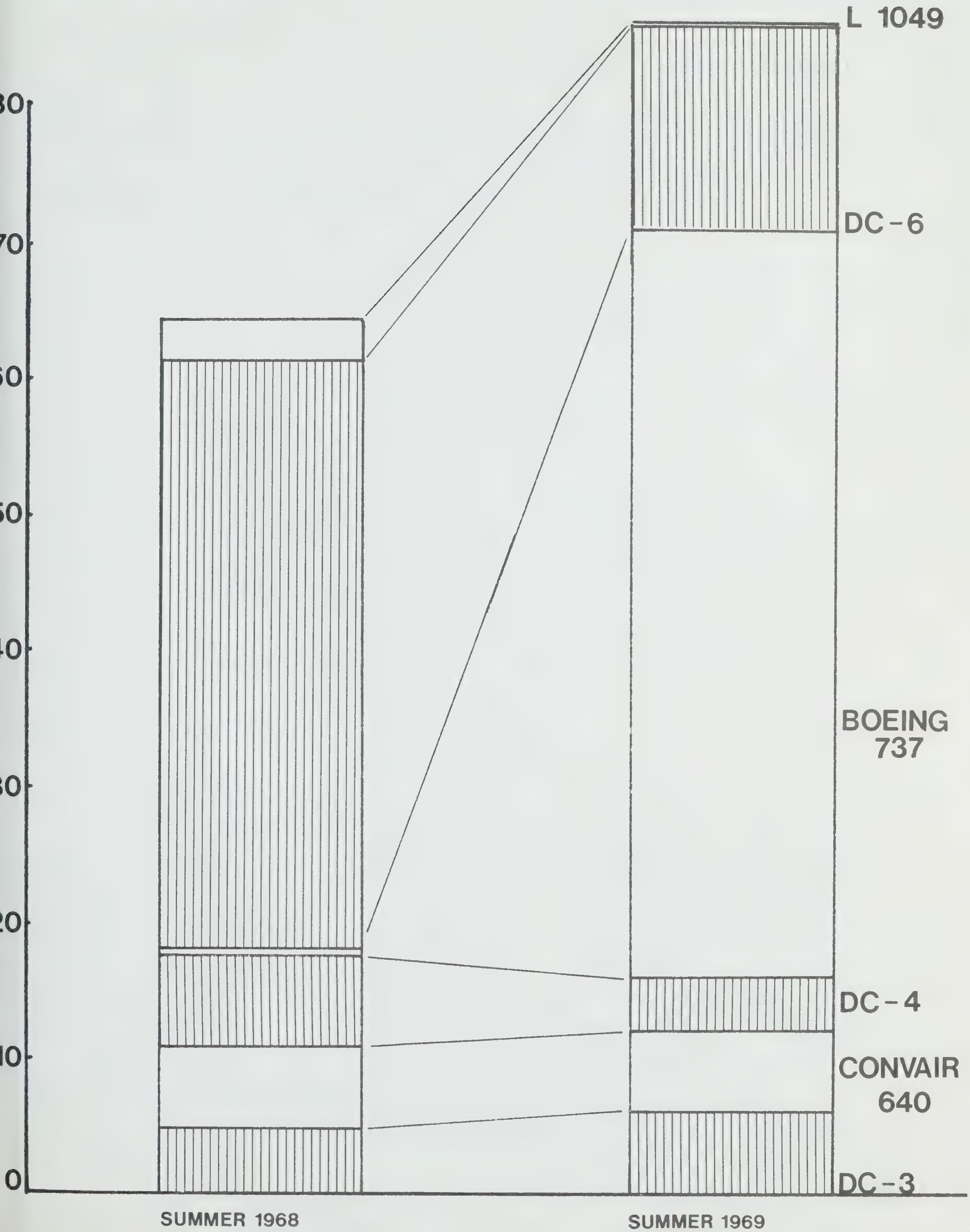


FIG. 5

AIRCRAFT USE, GROUP A,

PASSENGER - MILES

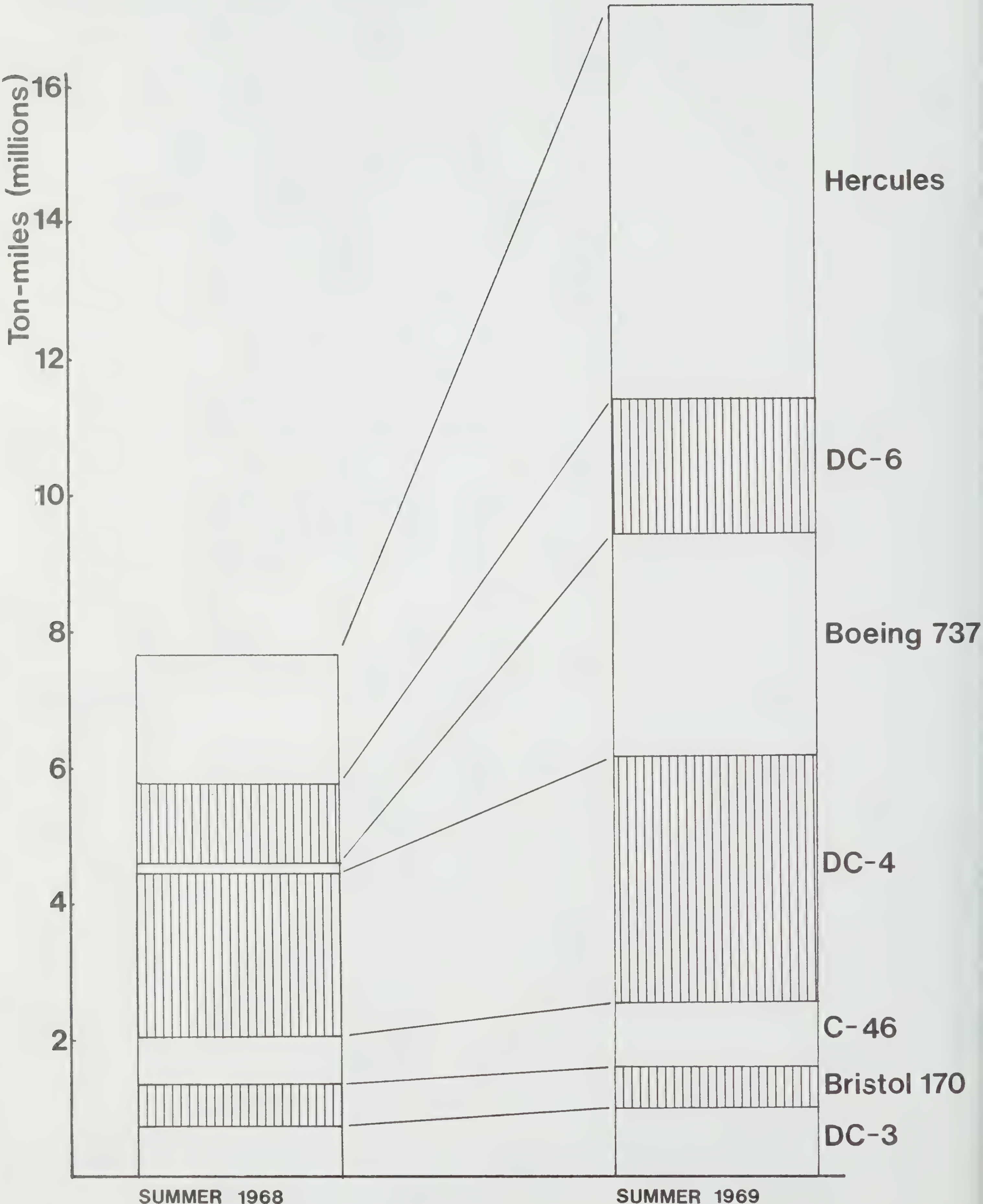


GROWTH RATE - 24 %

FIG. 6

AIRCRAFT USE, GROUP A,

FREIGHT TON-MILES

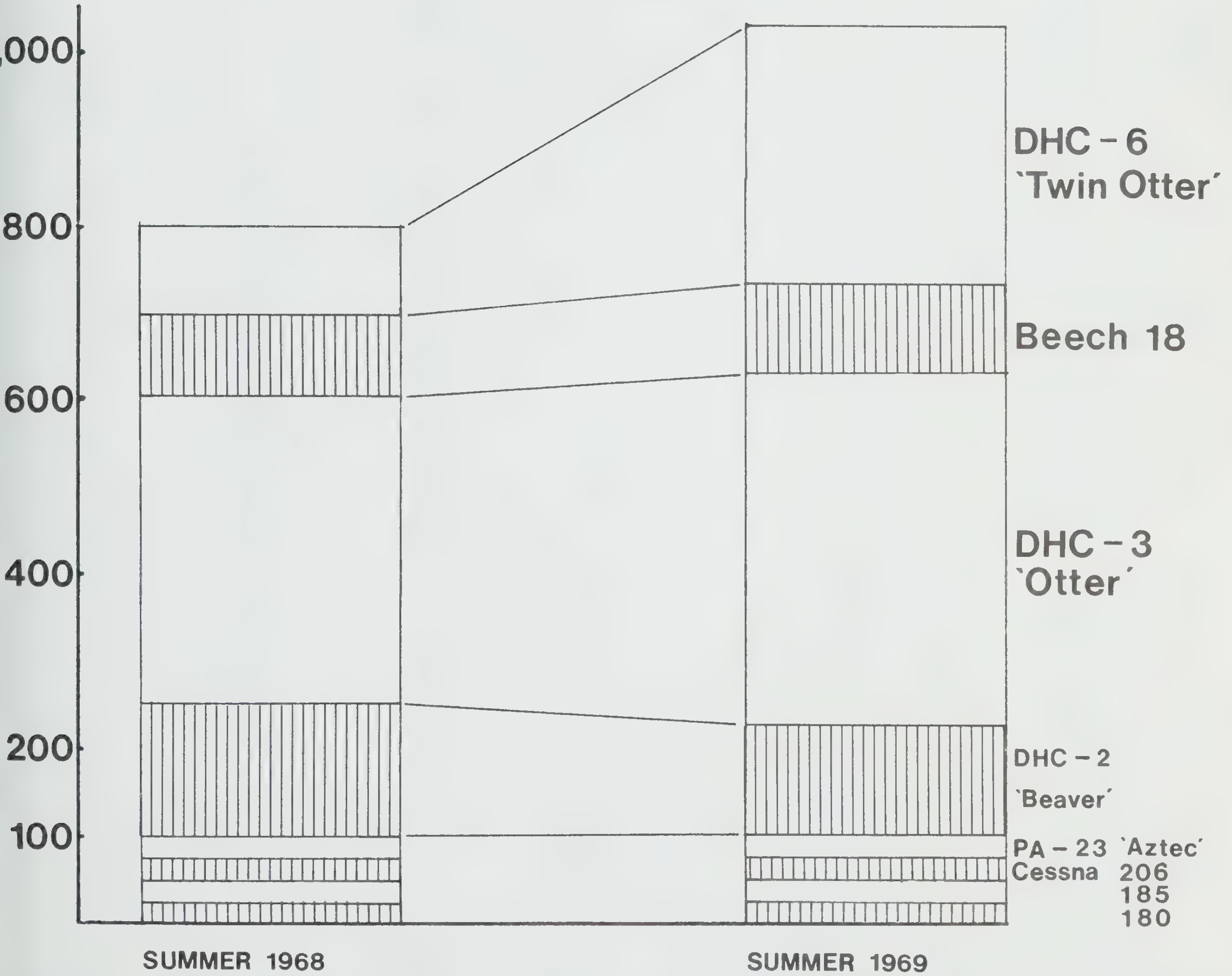


GROWTH RATE 125 %

FIG. 7

AIRCRAFT USE, GROUP B,

FREIGHT TON-MILES



GROWTH RATE - 26 %

FIG. 8

TRIP PURPOSE

PASSENGER-MILES

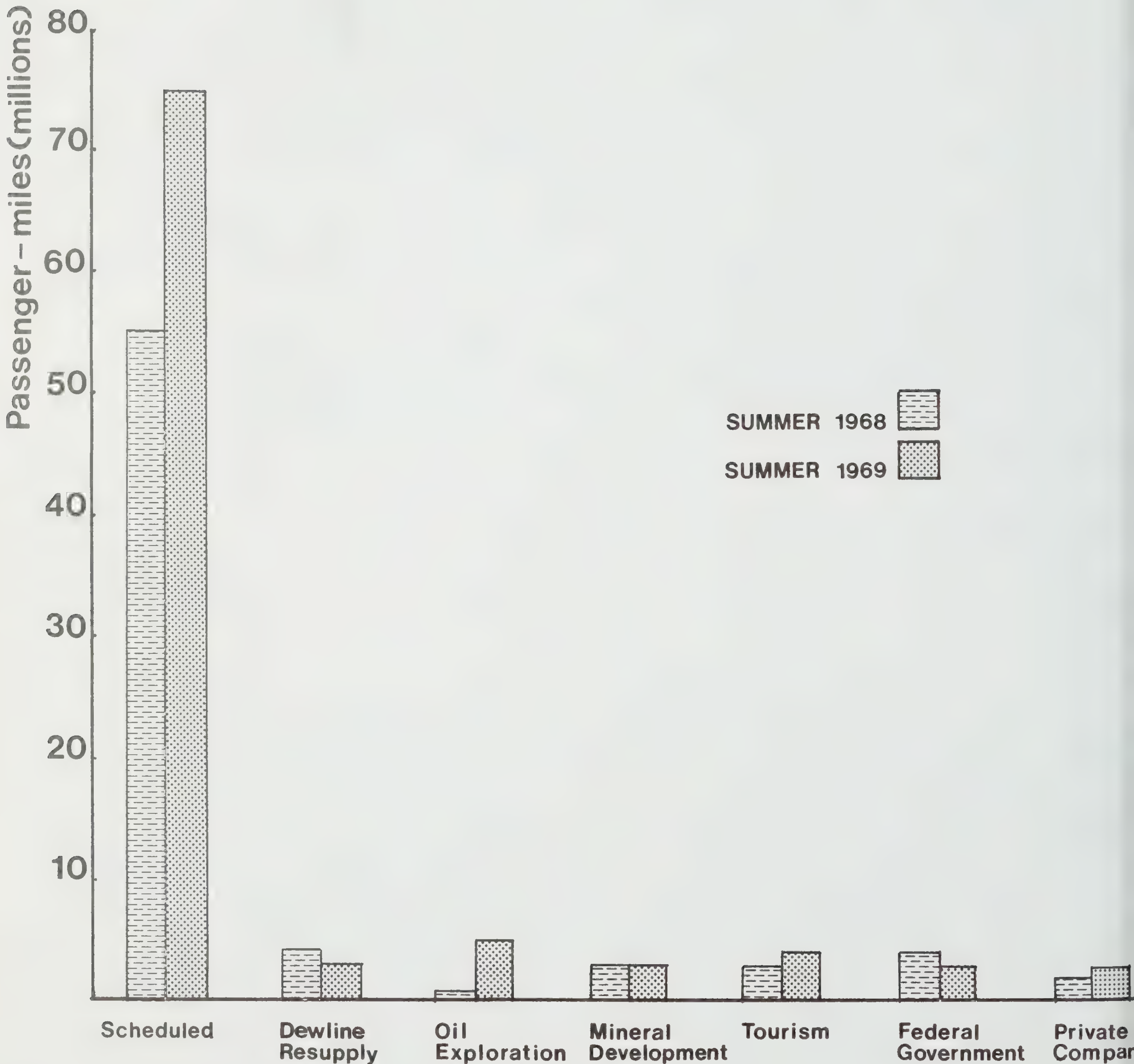


FIG. 9

TRIP PURPOSE

FREIGHT TON-MILES

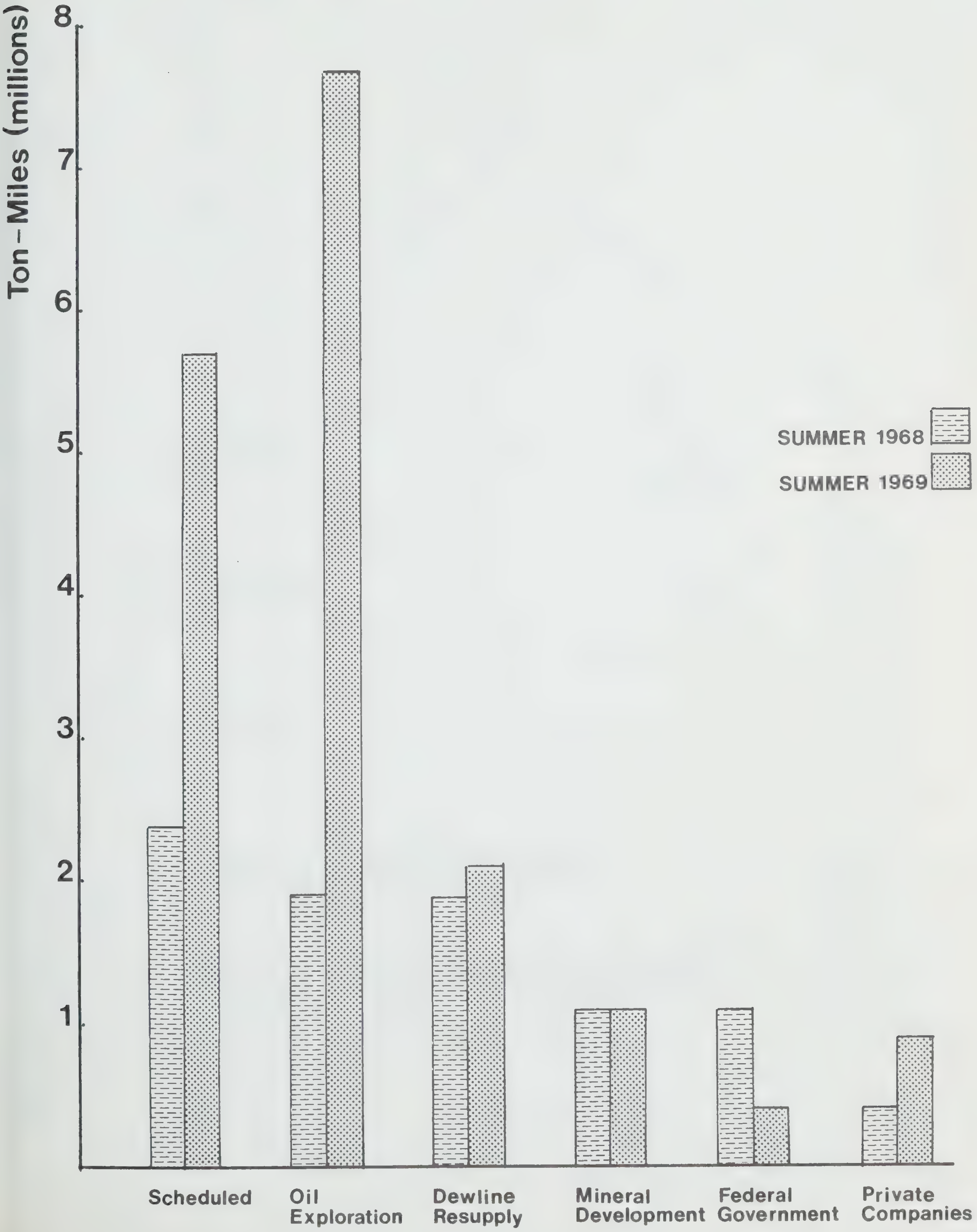


FIG. 10

HELICOPTER USE

BY PURPOSE, SUMMER 1968 AND 1969

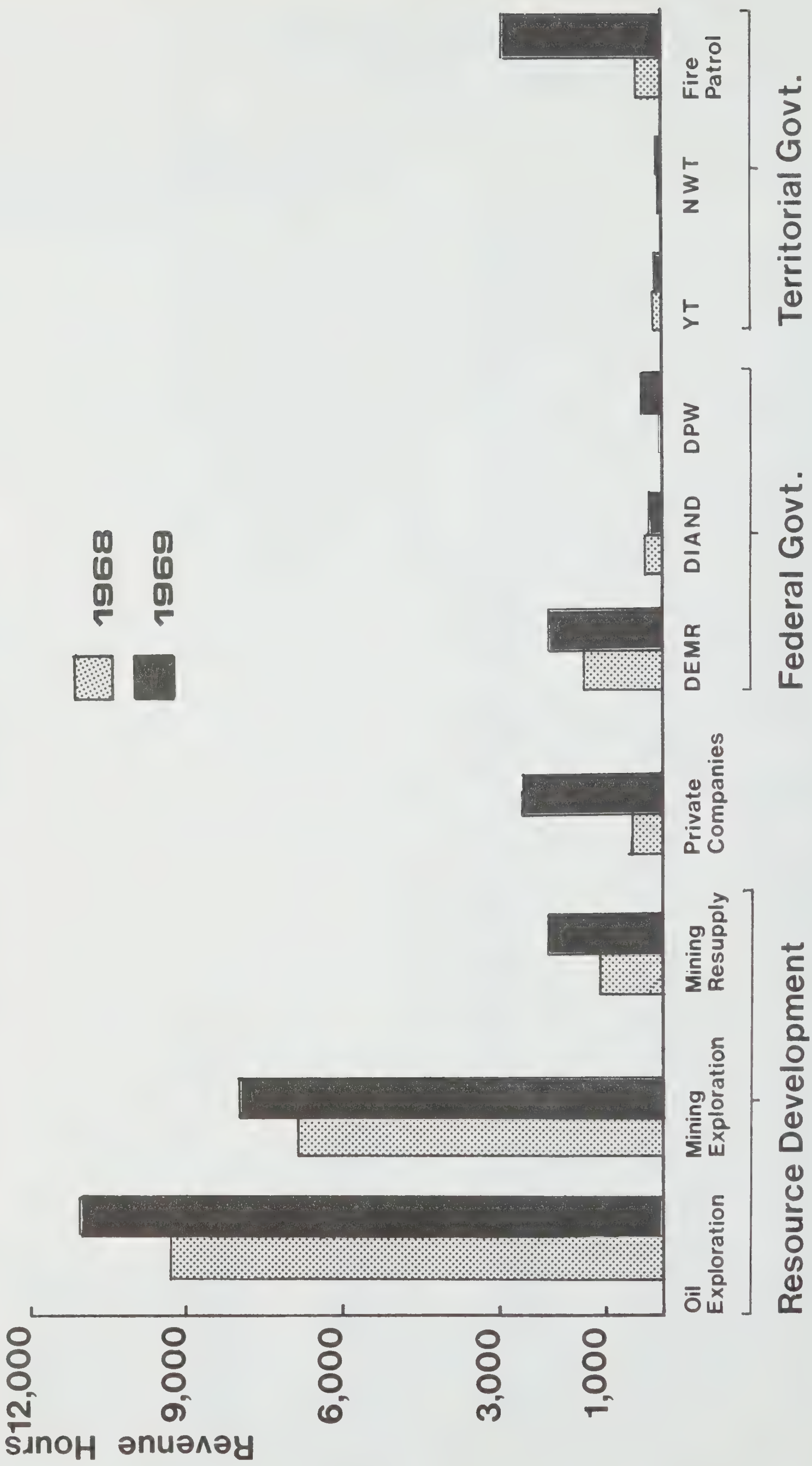


FIG. 11

AIR ROUTE NETWORK YELLOWKNIFE — FROBISHER (WINTER 1970)

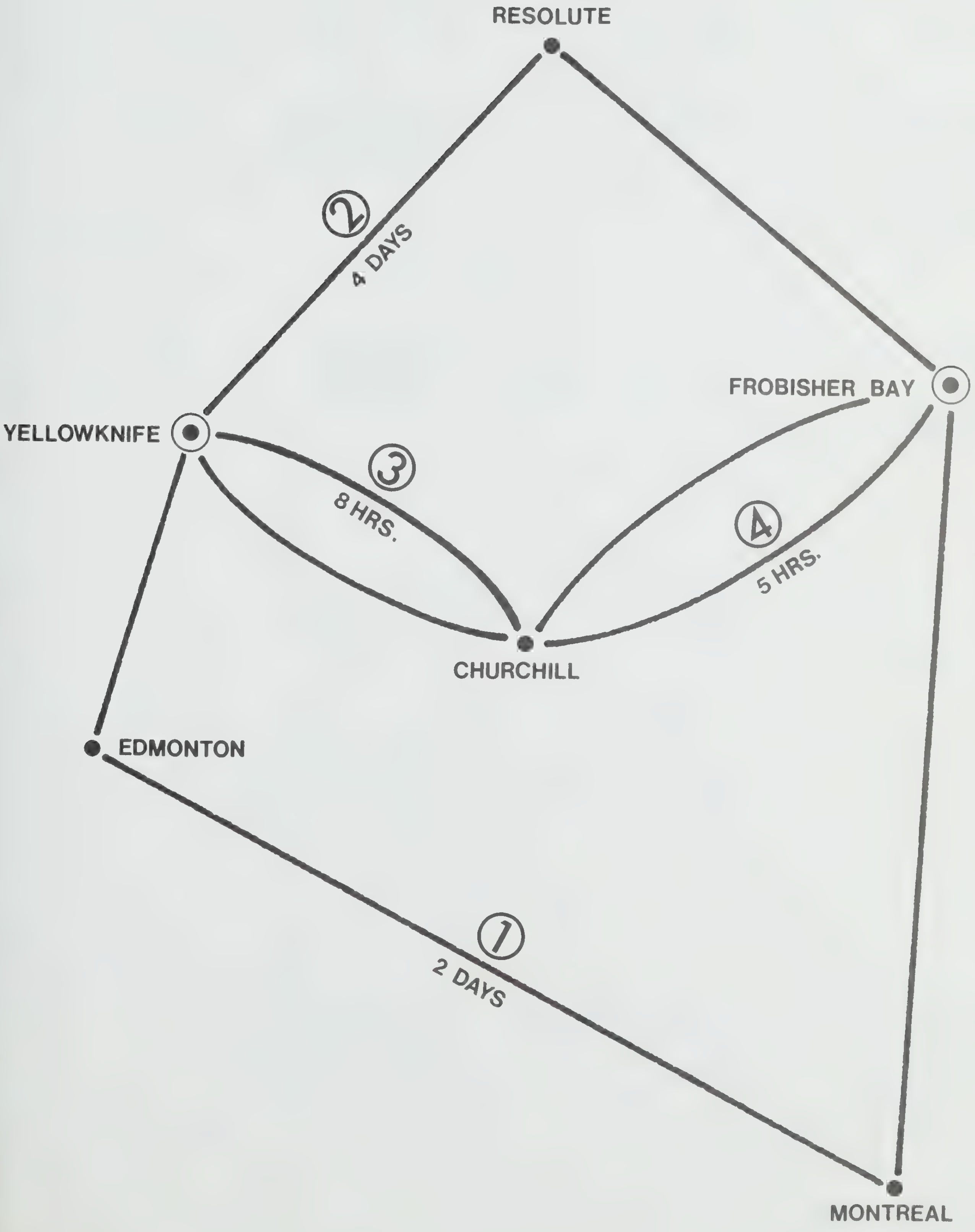


FIG. 12

WEST-EAST FARES (ONE WAY)

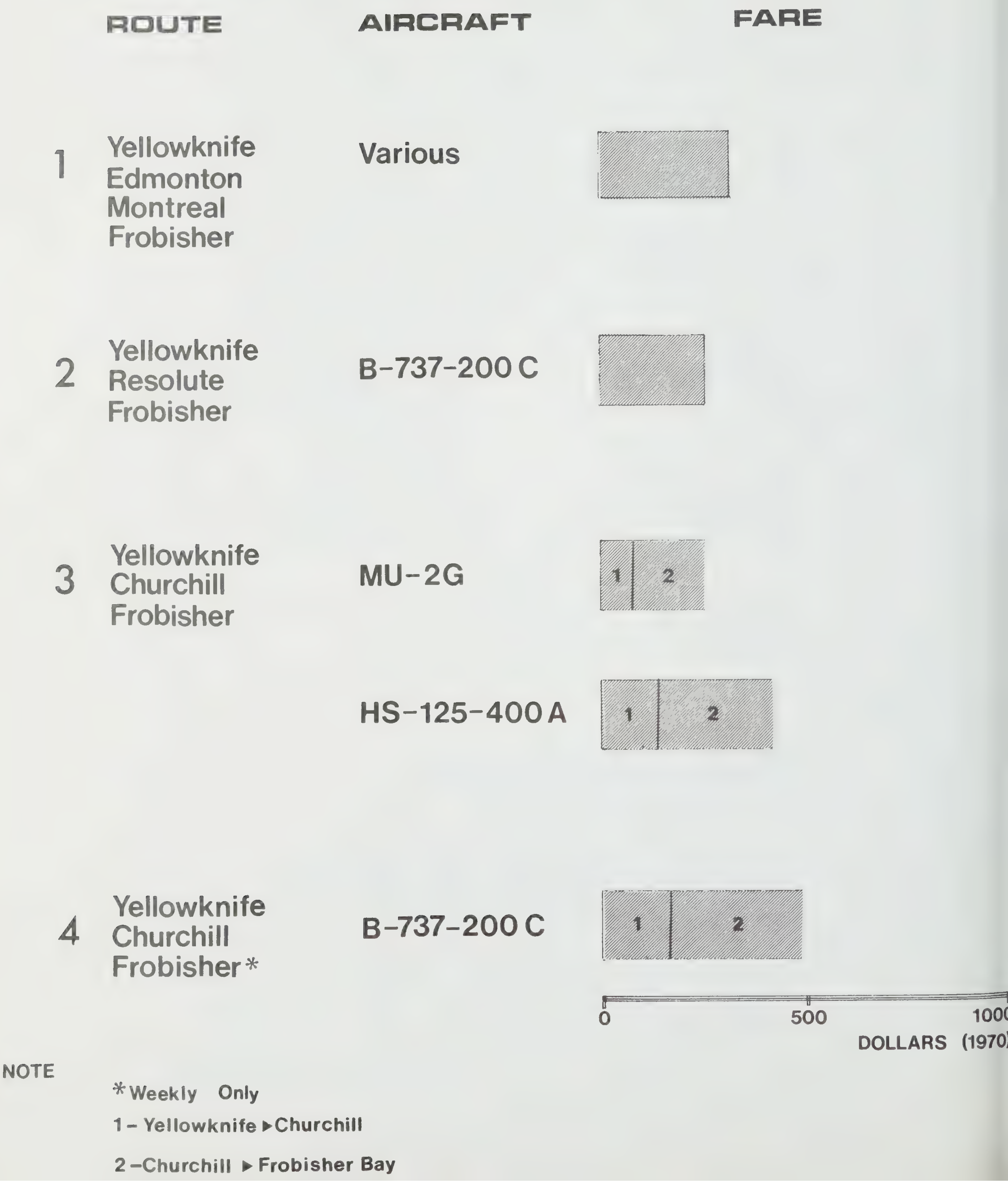


FIG. 13

A Resource Development Scenario

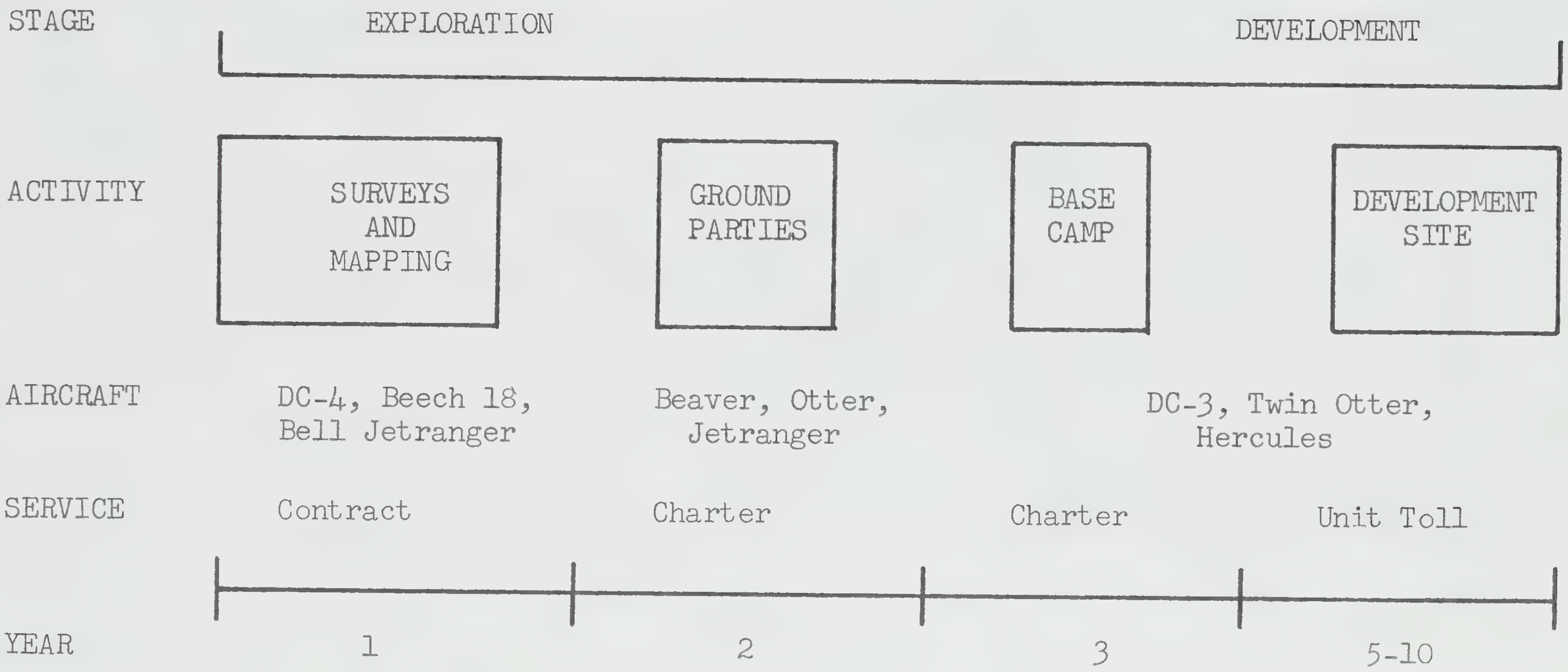
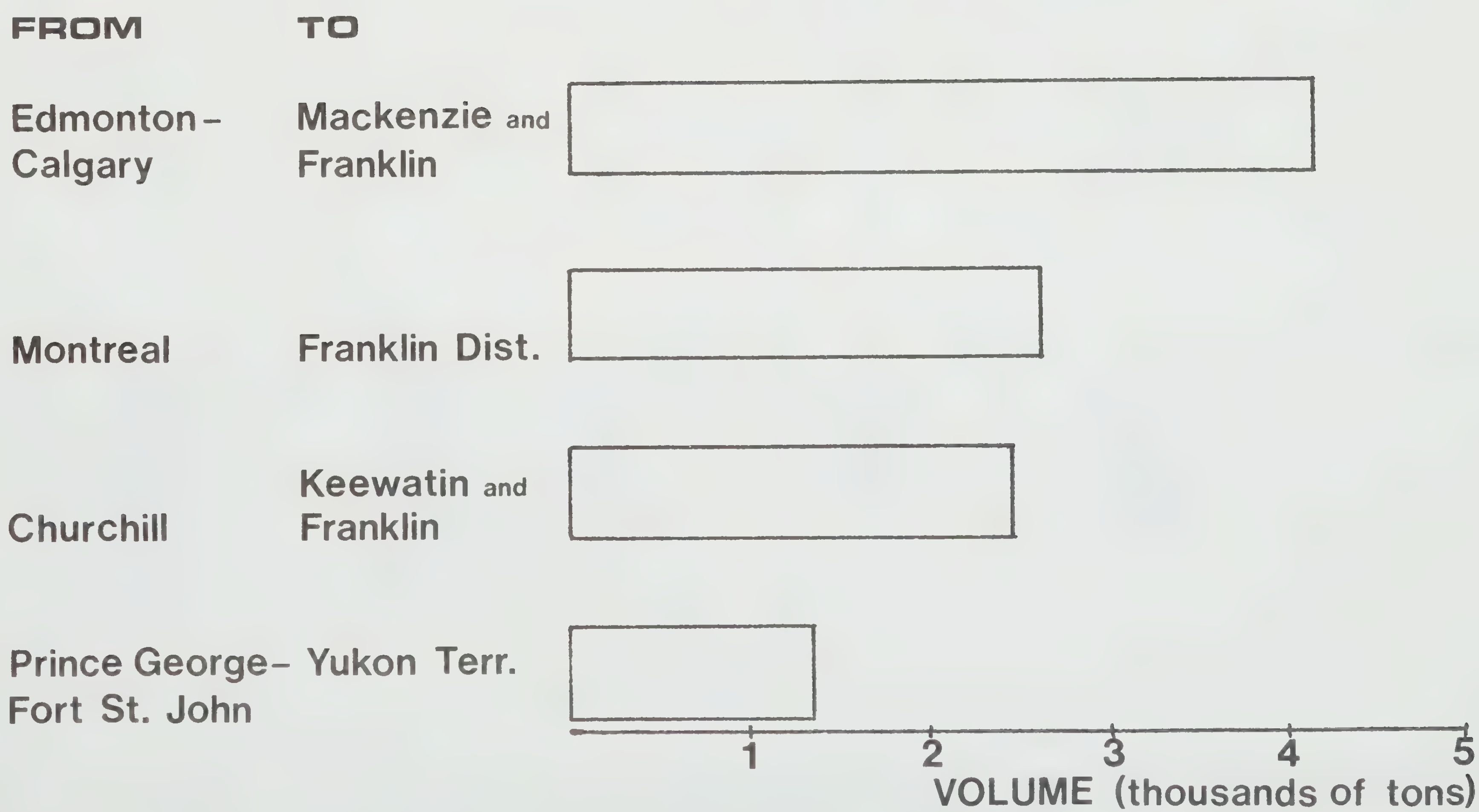


FIG. 14
CARGO AIRLIFTED INTO NORTHERN STATIONS, 1969



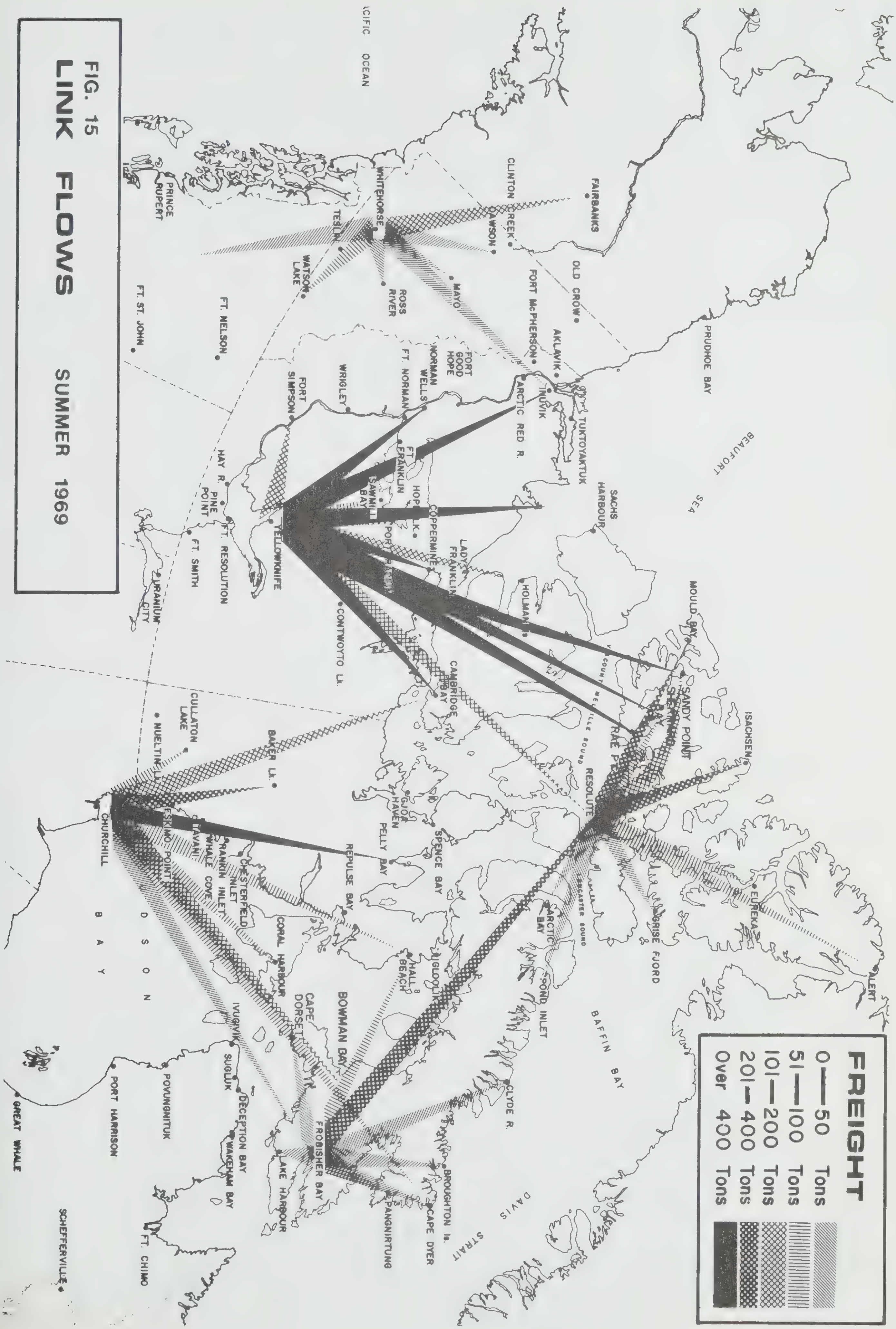


FIG. 15
LINK FLOWS
SUMMER 1969

AIR TRANSPORT IN NORTHERN CANADA

BY: MR. K.P. PEIFFER
Vice-President, Traffic Development, Nordair, Ltd.

The only available references to central government policy with respect to our air transport system in Canada are found in the Trans-Canada Airlines Act of 1937, the policy statement of the Minister of Transport on October 20th 1966, when he dealt with the Regional Air Carrier Policy, and in the National Transportation Act, assented to in February 1967.

Under the Trans-Canada Airlines Act authority was conferred upon Air Canada in the following manner:

> "The Governor in Council may authorize the Minister to enter into a contract with the Corporation (to be know as the Trans-Canada contract) for the organization, operation and maintenance by the Corporation of lines of aircraft (to be know as the Trans-Canada Lines) for the speedy and efficient transport of passengers, and goods <u>across Canada and between and within the several provinces thereof</u>, and between points in Canada and points outside of Canada, over routes wholly within or partly within and partly outside of Canada".

The Statement of Principles for Regional Air Carriers of October 1966 by the Minister of Transport stated:

"The role of regional air carriers is to operate local or regional routes............................, and to provide regular and scheduled service into the North".

The National Transportation Act declares:

"That an economic, efficient and adequate transportation system making the best use of all available modes of transportation at the lowest total cost is essential to protect the interests of the users of transportation and to maintain the economic well-being and growth of Canada, and that these objectives are most likely to be achieved when all modes of transport are able to compete under conditions ensuring that having due regard to national policy and to legal and constitutional requirements

(a) regulation of all modes of transport will not be of such a nature as to restrict the ability of any mode of transport to compete freely with any other modes of transport;

(b) each mode of transport, so far as practicable, bears a fair proportion of the real costs of the resources, facilities and services provided that mode of transport at public expense;

(c) each mode of transport, so far as practicable, receives compensation for the resources, facilities and services that it is required to provide as an imposed public duty; and

(d) each mode of transport, so far as practicable, carries traffic to or from any point in Canada under tolls and conditions that do not constitute

(i) an unfair disadvantage in respect of any such traffic beyond that disadvantage inherent in the location or volume of the traffic, the scale of operation connected therewith or the type of traffic or service involved, or

(ii) an undue obstacle to the interchange of commodities between points in Canada or unreasonable discouragement to the development of primary or secondary industries or to export trade in or from any region of Canada or to the movement of commodities through Canadian ports;

and this Act is enacted in accordance with and for the attainment of so much of these objectives as fall within the purview of subject matters under the jurisdiction of Parliament relating to transportation."

Within this framework of policy which gives no recognition to the essential social role of transportation in the North, air services in and to the Northwest Territories have been established over the years on an ad-hoc basis unassisted by much planning or direction from the government. Only in the last three to five years has there been evidence of planning by the private sector. and some government agencies.

Historically air-routes into and within the Canadian North have developed in a South-North direction, following the natural lines of supply of major industrial or military projects from Southern manufacturing or population centers to distribution centers in the North. In this way they have initially satisfied only two of the major objectives of Northern activity, ie., the defense requirement, and the economic activity associated with resource exploration. The social objectives associated with human resources in the Arctic, and the material needs of its indigenous population and their future as Canadian citizens were initially served by such air-routes only as a secondary objective, and almost on an incidental basis. Where such air-routes have been developed as unit toll services (1) on a scheduled basis with reasonable frequency, they have gradually become essential to the social well being of persons living in the Canadian North.

(1) Unit Toll Service are services for which charges are established per unit carried: ie. per passenger or per lb of freight.

Three major Northern air services supplying the needs of the Eastern, the Central, the Western and the High Arctic have been developed in this fashion (see Map No. 1).

The air-route between Edmonton - Yellowknife - Inuvik/Cambridge Bay, one of the oldest established aerial supply routes into the Arctic, sections of which operated on a scheduled basis as early as 1946, initially served the concentration of resource exploration in the Great Slave Lake area, the military objectives associated with the function of Cambridge Bay as a Western supply distribution point for the DEW-Line (1) and the logistic needs of the population concentration in the Mackenzie River delta and along the Mackenzie River generally.

Air service between Montreal - Fort Chimo - Frobisher Bay and Resolute Bay has developed along similar lines. While initially serving mainly the resource exploration objectives on the Ungava Peninsula, the route was soon extended to Frobisher Bay, originally the distribution base for the Eastern sector of the DEW-Line and now the main center of government activity in the Eastern Arctic. In the early 'Sixties this

(1) Distant Early Warning Line.

route was extended further to Hall Beach and Resolute Bay, center of the Joint Arctic Weather Station System, and jump-off base for the first phase of oil exploration activity in the High Arctic.

Service from Winnipeg through Churchill is the main aerial access route to the Central North or the Keewatin district. Originally, the service supported primarily a variety of economic activities connected with the Port of Churchill including the military and scientific activity there. Today its primary function is the support of the population in the Keewatin district.

The development pattern of all three routes has at least four things in common:

Firstly: They have all developed along the supply lines of major projects associated with military or economic objectives in the Arctic.

Secondly: They have all developed from sporadic charter services in their initial stage to scheduled service with gradually increased frequency. The transition from charter service to scheduled service has in most cases been brought about either

by the fact that the size of the projects served, soon made the "one shipper - one consignee" concept impractical, or by the fact that the projects served required ancilliary services which could no longer be matched with the requirements of the charterer. But whatever the cause, the transition from charter to schedule has produced results hardly imagined at the outset. Mail began to move along the scheduled routes bringing the advantage of reliable postal service to people which before had relied on the occasional charter flight for contact with the South. Food, dry goods, and other necessities of subsistence were landed at Northern centers with sufficient regularity to make it possible to programme their distribution to smaller surrounding communities. Scheduled air services of the feeder-line variety are now established at Frobisher Bay, Resolute Bay, Churchill, Yellowknife and Inuvik, serving a total of fifty-one communities in the Northwest Territories with DC-3 aircraft and with turbo-prop equipment such as the Skyvan and the Twin-Otter. (see Table I) Medical and administrative services have developed along the three major

Arctic supply routes and a pool of skills and knowledge connected with work in the Canadian Arctic has established itself at or close to the Southern base of these routes. The extent to which this is true can be seen from the fact that the majority of passenger travel on the main Arctic supply routes is en-route traffic and originates or terminates at or close to the Southern base of these routes. (see table II, 1,2,3).

Thirdly: All three main routes are today operated with modern jet or turbo-prop equipment. There are no communities of a similar size to Frobisher Bay, Yellowknife, or Inuvik in the South today which have the benefit of comparable regularly scheduled jet service.

Fourthly: All three routes have developed to the point where they are an integral and important part of life in the North and are essential to Northern development.

With the introduction of jet aircraft on the main Northern supply routes in 1968, the character of Northern air transportation has changed dramatically.

Pacific Western Airlines and Nordair both use the Boeing 737 airplane convertible to part cargo - part passenger configuration and capable of landing on gravel runways on their Northern scheduled services. This equipment has introduced reliability to the Arctic not previously envisaged and has provided a whole new concept of air transportation in the North.

Where only two years ago scheduled service between Frobisher Bay and Montreal operated three times a week and would take six to seven hours with piston engine aircraft such as the DC-4, DC-6 or Super Constellation this same trip now takes three hours on board a modern jet liner and frequency is six times per week. Where once a trip from a Coastal settlement in the Western Arctic to Edmonton was dependent on the sporadic operation of a charter flight to a point where connection to a flight South was available, this same trip can today be made on a scheduled basis over its entire length. Where once foodstuffs and perishables had to be unloaded by hand, exposing goods to severe temperature conditions, today the modern freight handling equipment assures the transfer from aircraft to warehouse with minimum exposure to the elements.

The benefits which derive from frequency of scheduled air service, not only from a point of view of logistics but also from

a social point of view, are well know and particularly well understood in the North.

The Federal Government, through its regulatory agency, the Air Transport Committee of the Canadian Transport Commission, formely the Air Transport Board, has until recently played a passive role in the development of Northern air services. In 1968, under the Chairmanship of the Honourable J.W. Pickersgill, a series of hearings were held by the Air Transport Committee in Yellowknife and Frobisher Bay, to review the requirements for and adequacy of existing and proposed commercial air services and to consider some seven specific applications for licences or amendments of licences for the operations of commercial air services in this area. This represented the first Hearing of a Committee of the Canadian Transport Commission to be held in the Northwest Territories. Subsequently, the Committee issued a Decision, entitled "General Conclusions of the Air Transport Committee Resulting from the Conduct of a Review of the Commercial Air Services in the Northwest Territories", in which it recognized the benefits of scheduled air services and contrasted them to charter operations in these words: "If economical, viable air services are to be developed and maintained in the Northwest Territories, it follows that departments and agencies of government should, wherever possible, use the regular air services in the North and that short-term economies which might result from chartering services from southern Canada should be balanced

against the long-term economy of having efficient and economical services available to the North on a year-round basis." In this same decision it is of interest to note that the Committee also recognized that an East to West service linking Frobisher Bay and Yellowknife would be desirable, if economically feasible. But, at the same time emphasized that such a route would not be eligible for subsidy either then or in the foreseeable future. The Committee also observed that: "Historically, the basis of air service in the North is that of three regional carriers, one operating from Montreal to the Eastern Arctic, another from Winnipeg to the Central Arctic, and the third from Edmonton to the Mackenzie Valley and the Coppermine area. All three services are essential to effective air service within the Northwest Territories. It is, therefore, a great importance that these carriers remain economically viable".

In the light of this pertinent observation and directive, it is surprising that the Federal Government is heavily involved in Northern air-freighting and transport operations on a charter or contract basis through its Crown Corporation, Eldorado Mining, as well as through its substantial participation in Panarctic's oil exploration programme.

There are still many, perhaps too many, air services in the North operated on a regular or irregular basis by charter or contract. These services are operated for the convenience and benefit of one customer, and while they may offer some rate advantages to this customer, they are of no social benefit to the area which they serve. A case in point is the lateral DEW-Line resupply operation, which for many years has linked the Eastern and Western Arctic. As it serves military needs exclusively, this service has done nothing towards developing the East-West air service link now sought by the government of the Northwest Territories.

Contract operations such as the DEW-Line do not appear to warrant the use of modern aircraft as the operation to this day utilizes DC-4, C-46 and DC-3 aircraft, although it has been demonstrated how the DEW-Line resupply could be accomplished using a combination of available scheduled services with modern jet equipment and to a much lesser degree charter aircraft.

Also management personnel of the Department of Indian Affairs and Northern Development and now those of the Northwest Territorial Government and the Department of National Health and Welfare historically have used charter flights for their regular

inspection trips. In addition, the government uses military transport for "VIP" visitors or for special trips in many cases where scheduled services are available.

So long as these practices continue the by-product benefits to the residents of the North, which flow from scheduled air services will not be realized and the longer it will take to "open up the North".

Notwithstanding the foregoing, it must also be stated that during the last two years government agencies have made increased use of scheduled services for movement of cargo North on a regular basis throughout the year. However, a substantial amount of cargo still moves by sea in the two to three months that the ports are free of ice. It must be assumed that the decision not to make more use of the available air services is based mainly on the cost differential between air and sea. But, if a proper air transport system with lower unit rates is to emerge in the North consideration will have to be given to moving more cargo by air. The increase in cargo movement would eventually result in a decrease in the cost per unit, as it would permit the Northern Carrier to make more efficient use of the productivity of his jet aircraft. Consideration will also have to be given to

the recommendations of Air Transport Committee Decision No. 2624 particularly where it suggests that departments and agencies of government should, whenever possible, make use of the regular air services provided in the North. However, this should also include the use of scheduled services by Crown Corporations and Military Agencies. Only through such planned use of the existing transport facilities will it be possible to build up a system of scheduled services from which the maximum social and economic benefits for the North will result.

The importance of improving aids to Air Navigation and introducing weather reporting services so as to achieve more reliability in the Air Service provided with smaller aircraft to the more isolated settlements in the North are covered by separate papers but brief mention is made here of these matters. In Decision Serial No. 2624, the Committee noted that aids to aerial navigation did not exist over a considerable part of the most direct route between Yellowknife and Frobisher, and it seemed to the Committee that careful study should be given by the Commission in consultation with the Department of Transport to the relative cost and benefits of providing such aids. To our knowledge only few steps have been taken to improve Air Navigation facilities in this area nor has the recommended study commenced.

In the Decision previously referred to, the Canadian Transport Commission recognized the need for airport improvement, when it pointed out that: "One of the difficulties of providing economical, efficient and adequate service in the Northwest Territories is the lack, in many of the settlements, of airstrips available on a year-round basis. It is the intent of the Commission to have consultations with the Research Division of the Commission and other appropriate Federal Government Departments on this subject." Some action has taken place since this Decision, but there is still much room for improvement. Except at main airports such as Frobisher, Resolute, Inuvik and Yellowknife the airports are not under the management of the Ministry of Transport. Some airports which are used for scheduled air services are under United States Air Force control and some are under Northwest Territories Government jurisdiction, others have been developed and are maintained at least in part on a voluntary basis by local residents.

A programme for the improvement of certain airports was announced by the Minister of Indian Affairs and Northern Development

on June 8th. Design is by the Ministry of Transport and construction is carried out by the engineers of the Canadian Armed Forces. Priorities have been set by D.I.A.N.D. and work has already commenced at Pangnirtung, a settlement which currently has a perfectly adequate airstrip of 1700 feet in length and is receiving scheduled service three times weekly with aircraft capable of STOL performance. On the other hand at least two Northern settlements which at present do not have any airstrips at all, namely Port Burwell and Lake Harbour, are not included in the programme.

The Northwest Territories of Canada with an area of approximately 1,200,000 square miles and a population of only 32,000 (1) is the largest under developed area at least in the Western World. The users and the operators of the transport systems in the Canadian North are greatly concerned over the large sums of the Canadian taxpayer's money being spent on aid

(1) 1969 estimates as per 1969 Annual Report of the Government of the Northwest Territories.

to so called under-developed countries both as direct foreign aid and through the medium of the International Development Agency. One must wonder whether the allocation of a small percentage of such foreign aid funds to Northern Airports, aids to navigation and if necessary assistance towards the development of a transportation network spanning our entire North country would not be more advantageous to Canadians.

While the introduction of modern equipment and the establishment of scheduled services to isolated settlements together with increased frequency between North and South has resulted in an overall reduction in the cost of transportation,these benefits are sometimes overshadowed by the fact that fares and rates for Northern air services are generally higher than those for equivalent mileage in the South. It is sometimes not recognized that practically all elements of cost of airplane operation in the North are considerably higher than in the South. For example:

Fuel costs as much as 78 percent more than at points in Southern Canada (1); labour costs inflated by Northern allowances and other fringe benefits; low utilization of ground equipment

(1) At Frobisher Bay, jet fuel for use on domestic flights costs 78 percent more than in Montreal. The average cost for turbo-fuel to the three Regional Carriers providing Northern services is 40 percent higher than the average cost of turbo-fuel to CPAir and Air Canada. (Source DBS Catalogue No. 51-002, January - March 1970)

and station personnel caused by low flight frequencies and steadily increasing station costs in the North brought about by the gradual increase of the cost of all services, from airport charges and electricity to garbage disposal.

Northern rate structures also reflect such anomalies experienced in Northern transportation as uni-directional freight traffic flow and significant seasonal variations in load factors. The cost-contributing aspects of seasonal variation in utilization of equipment on Northern services exceeding +20 percent and -20 percent of the average is obvious. Various devices have been used to equalize this seasonal utilization. Nordair has achieved some success to equalize this by attracting to air movement a sizeable portion of supplies previously moved by sealift. Nordair achieved this through a combination of incentive rate structures, combined with transportation cost economies associated with reduced inventory and warehousing costs, reduced handling and spoilage, and reduced packaging requirement; all of which would derive from an even year-round air supply programme. This year-round flow of traffic permits rate levels substantially lower than what is customary where seasonal traffic prevails. Nordair's ton/mile revenue, as a

result of its incentive rate structure, is 32 percent lower than the average for the Regional Carriers (1). Unfortunately, even this incentive rate structure has not eliminated seasonal traffic altogether, mainly because traditional purchasing practices are still partially meeting sealift requirements. Therefore, Northern carriers must compensate the resultant problem of seasonal and periodic under-utilization of their equipment on scheduled services to and from the North on weekdays by operating charters to the South on weekends. In fact, if this kind of additional utilization were not possible, jet service, as we know it today, would not be available, at least, in the Eastern Arctic.

The cost of Northern operations must also reflect the distance of alternate airports from the intended destination insofar as this requires the carrying of fuel reserves which reduce the payload and the productivity of the aircraft.

The foregoing makes it clear, that Northern rates are established as a direct function of the costs which are experienced in this type of operation, and fares and rates cannot come down, unless ways are found to reduce costs. It is possible that in some areas efficiency could be improved, even though on the average the Regional carriers providing Northern service are quite

(1) DBS Catalogue No. 51-001 (July 1970) Table 5, Item 25.

efficient, and, in certain respects more so than the trunk lines operating in the South (1). But some of the elements of cost are outside of the control of the carriers, for example, the cost of depreciation of equipment and the financing charges are both extremely high and are related to the capital cost of the aircraft.

This capital cost of jet aircraft is therefore worthy of consideration. They cost about $6,000,000. per unit including spare parts, handling equipment, special tools and sales tax. The financing of these aircraft has placed great strain on the resources and credit available to regional carriers. The cost of financing to regional carriers is approximately 10½% which is 4% more than the cost of Air Canada's aircraft financing because the rate charged that Crown Corporation by the government is 6½%.

A similarly ironic situation is, that it is not possible for a Canadian Air Carrier operating in the North to purchase the DHC-6 Twin-Otter, a Canadian developed and manufactured aircraft, ideally suited for short airstrip operation, on terms as favorable as are available to a foreign buyer through the facilities of the Export Credit Insurance Corp., a Canadian Crown Corporation.

(1) Operating Revenue per Employee for Air Canada and CPAir during the first seven months of 1970 was $15,570., while the three Regionals serving the North averaged $19,750. per employee.

If this aircraft had been in use in the Canadian North before it was in use in foreign countries, its export sales might have been favorably influenced and it could have had a profound influence upon the earlier mentioned airport development programme in the North.

Acquisition of equipment is an area in which the Federal Government recognized the desireability of assisting Regional Carriers providing air service in the North. The Minister of Transport in the Summary of the October 1966 Statement of Principles stated:

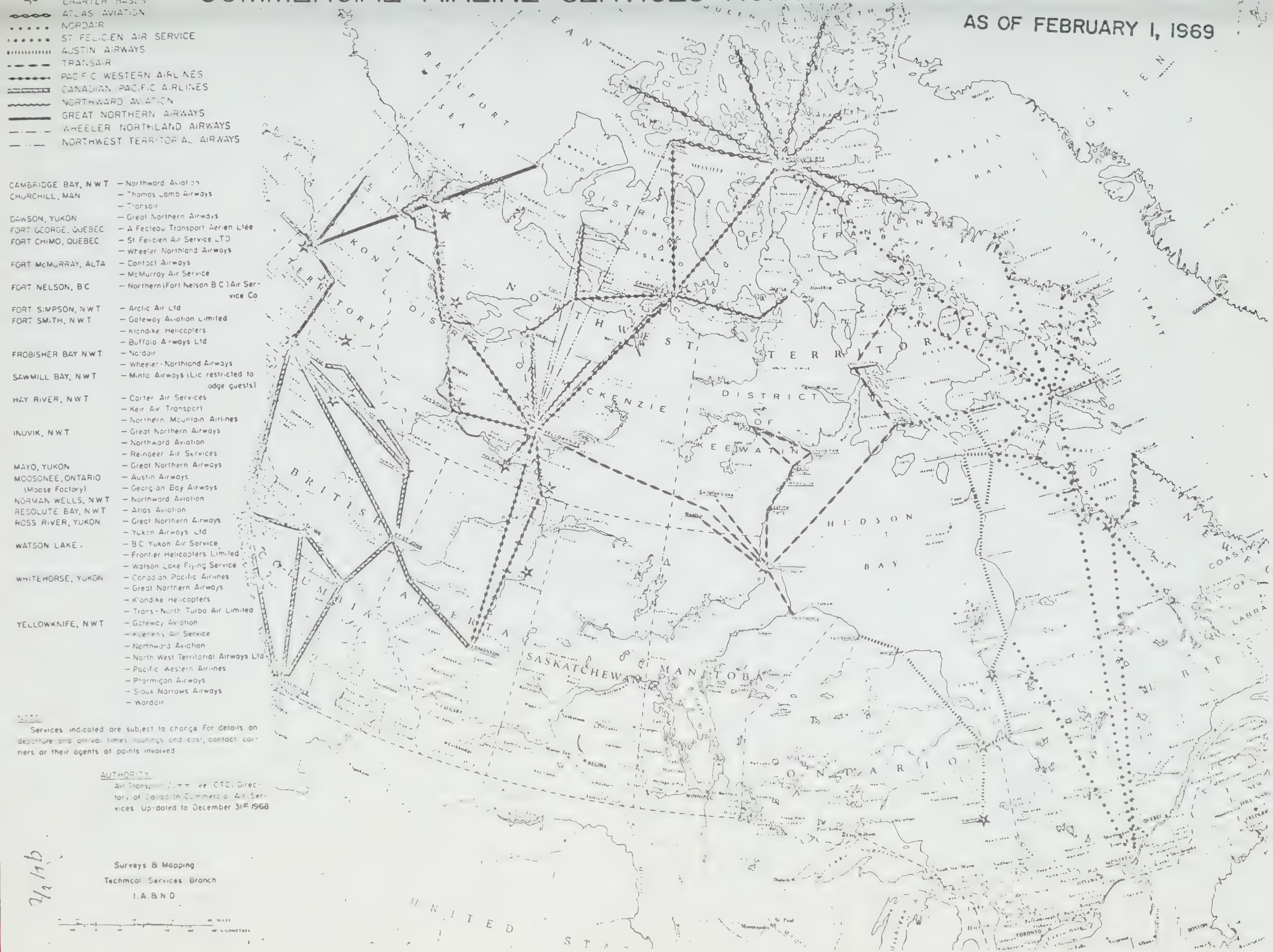
> "Steps will be taken to assist regional carriers to deal with acquisition of aircraft by development of a scheme for consultation between government and the carriers regarding plans for new aircraft; and by a special investigation designed to explore the possibility of developing a joint approach to this problem on the part of the carriers."

No such assistance has been forthcoming, nor, to our knowledge is it under consideration. The climate, in fact, created to a large degree by the inconsistent application and the sporadic implementation of the Regional Air Carrier Policy has

made the profitability of the Northern Air Carriers unattractive to the investing public which in turn has made the financing of new aircraft both costly and difficult

In summary, the Regional Carriers providing scheduled air services to and in the North occupy a position of considerable importance to Canada as a whole and to the vast area of the Northwest Territories in particular. It is apparent from the foregoing that Northern transportation would benefit from a closer working relationship between the carriers and both the Central government and the government of the Northwest Territories. It is equally apparent that the economic health of the carriers should be of prime concern if they are to maintain the capability of providing adequate air services to the North.

The Ministry of Transport, the Department of Indian Affairs and Northern Development and the Governments of the Yukon and the Northwest Territories must therefore be congratulated for organizing and convening at this time this Arctic Transportation Conference to discuss Northern Transportation which hopefully will resolve the problems which are besetting it today.


AS OF FEBRUARY 1, 1969
ATLAS AVIATION
NORDAIR
ST FELICIEN AIR SERVICE
AUSTIN AIRWAYS
TRANSAIR
PACIFIC WESTERN AIRLINES
CANADIAN PACIFIC AIRLINES
NORTHWARD AVIATION
GREAT NORTHERN AIRWAYS
WHEELER NORTHLAND AIRWAYS
NORTHWEST TERRITORIAL AIRWAYS
CAMBRIDGE BAY, NWT — Northward Aviation
CHURCHILL, MAN — Thomas Lamb Airways
— Transair
DAWSON, YUKON — Great Northern Airways
FORT GEORGE, QUEBEC — A Fecteau Transport Aerien Ltée
FORT CHIMO, QUEBEC — St Felicien Air Service LTD
— Wheeler Northland Airways
FORT McMURRAY, ALTA — Contact Airways
— McMurray Air Service
FORT NELSON, BC — Northern (Fort Nelson B C) Air Service Co
FORT SIMPSON, NWT — Arctic Air Ltd
FORT SMITH, NWT — Gateway Aviation Limited
— Klondike Helicopters
— Buffalo Airways Ltd
FROBISHER BAY NWT — Nordair
— Wheeler-Northland Airways
SAWMILL BAY, NWT — Minto Airways (Lic restricted to lodge guests)
HAY RIVER, NWT — Carter Air Services
— Keir Air Transport
— Northern Mountain Airlines
INUVIK, NWT — Great Northern Airways
— Northward Aviation
— Reindeer Air Services
MAYO, YUKON — Great Northern Airways
MOOSONEE, ONTARIO (Moose Factory) — Austin Airways
— Georgian Bay Airways
NORMAN WELLS, NWT — Northward Aviation
RESOLUTE BAY, NWT — Atlas Aviation
ROSS RIVER, YUKON — Great Northern Airways
— Yukon Airways Ltd
WATSON LAKE — BC Yukon Air Service
— Frontier Helicopters Limited
— Watson Lake Flying Service
WHITEHORSE, YUKON — Canadian Pacific Airlines
— Great Northern Airways
— Klondike Helicopters
— Trans-North Turbo Air Limited
YELLOWKNIFE, NWT — Gateway Aviation
— Northward Aviation
— North West Territorial Airways Ltd
— Pacific Western Airlines
— Ptarmigan Airways
— Sioux Narrows Airways
— Wardair
Services indicated are subject to charge For details on departure and arrival times routings and cost, contact carriers or their agents at points involved
AUTHORITY
Air Transport Committee CTC Directory of Canadian Commercial Air Services Up-dated to December 31st 1968
Surveys & Mapping
Technical Services Branch
I.A.& N.D
BEAUFORT SEA
YUKON TERRITORY
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
DISTRICT OF FRANKLIN
VICTORIA ISLAND
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
HUDSON BAY
UNITED STATES
DAVIS STRAIT
BAFFIN BAY
COAST OF LABRADOR
YELLOWKNIFE
EDMONTON
REGINA
WINNIPEG
TORONTO
MONTREAL
QUEBEC
BOSTON

9/1/46

TABLE I

UNIT TOLL SERVICES AVAILABLE FROM MAJOR DISTRIBUTION CENTERS IN THE NORTH[1]

Inuvik, N.W.T. (serves 9 different communities)	- Fort McPherson	Northward Aviation Ltd	Class
	Aklavik	" " "	"
	Arctic Red River	" " "	"
	Tuktoyaktuk	" " "	"
	- Old Crow	Great Northern Airways	Class
	Sachs Harbour	" " "	"
	Clinton Creek	" " "	"
	Tuktoyaktuk	" " "	"
	Dawson	" " "	"
	- Mayo	" " "	Class 2
	Dawson	" " "	"
Yellowknife (serves 16 different communities)	- Coppermine	Northward Aviation Ltd	Class 3
	Holman Island	" " "	"
	- Hope Lake	North West Territorial Airways Ltd	Class 3
	Port Radium/Sawmill Bay	" " " "	"
	Coppermine	" " " "	"
	Holman Island	" " " "	"
	Melville Island	" " " "	"
	Lady Franklin	" " " "	"
	Cambridge Bay	" " " "	"
	- Fort Simpson	Pacific Western Airlines[2]	Class 1
	Wrigley	" " "	"
	Norman Wells	" " "	"
	- Fort Resolution	" " "	Class 2
	Fort Smith	" " "	"
	Fort Chipewyan	" " "	"
	- Cambridge Bay	" " "	Class 2
	Resolute Bay	" " "	Class 3
	- Snowdrift	Ptarmigan Airways Ltd	Class 3
	Fort Reliance	" " "	"

(1) "Directory of Canadian Commercial Air Services," Canadian Transport Commission, Air Transport Committee, 1970.

(2) Based on published schedules.

rchill	-	Eskimo Point	Transair/Midwest[1]	Class 3
rves 8 differ-		Whale Cove	" "	"
communities)		Chesterfield Inlet	" "	"
		Rankin Inlet	" "	Class 2
		Baker Lake	" "	"
		Coral Harbour	" "	"
		Repulse Bay	" "	Class 3
		Hall Beach	" "	"
bisher Bay	-	Broughton Island	Nordair Ltd[1]	Class 3
rves 10 differ-		Pangnirtung	" "	"
communities)		Cape Dyer	" "	"
		Cape Dorset	" "	"
		Coral Harbour	" "	"
		Clyde River	" "	"
		Igloolik	" "	"
		Hall Beach	" "	"
	-	Lake Harbour	Wheeler-Northland	Class 3
		Wakeham Bay	" "	"
olute Bay	-	Mould Bay	Atlas Aviation Ltd	Class 3
rves 9 differ-		Isachsen	" " "	"
communities		Eureka	" " "	"
		Arctic Bay	" " "	"
		Grise Fjord	" " "	"
		Pond Inlet	" " "	"
		Melville Island	" " "	"
		Strathcona Sound	" " "	"
		Mayda Lake	" " "	"

)Based on published schedules

TABLE II

ORIGIN & DESTINATION OF PASSENGERS
TRAVELLING ON MAJOR NORTHERN SUPPLY
ROUTES IN 1969[1]

1. Montreal - Fort Chimo - Frobisher Bay - Resolute Bay

Between / and	En-Route	Off-Route	Total
Fort Chimo			
British Columbia		10	
North West Territories			
Frobisher Bay	80		
Yellowknife		5	
Manitoba		20	
Ontario		60	
Quebec			
Montreal	1,845		
Quebec City		100	
	1,925 (92%)	195 (8%)	2,120 (100%)
Frobisher Bay[2]			
Alberta		345	
British Columbia		10	
North West Territories			
Resolute Bay	335		
Fort Smith		5	
Yellowknife		35	
Manitoba		85	
Maritime Provinces		65	
Ontario		1,075	
Quebec			
Chibougamau		60	
Montreal	5,055		
Quebec City		65	
North Shore		25	
Val d'Or		10	
Saskatchewan		20	
Yukon		20	
	5,390 (75%)	1,820 (25%)	7,210 (100%)

[1] Based on DBS, Aviation Statistic Branch, O & D Domestic 1969

[2] O & D do not include trips via Frobisher to Eastern Arctic settlements served from Frobisher Bay.

1. Montreal - Fort Chimo - Frobisher Bay - Resolute Bay (Cont'd)

Between/and	En-Route	Off-Route	Total
Resolute Bay[1]			
Ontario		295	
Quebec			
Montreal	1,320		
Quebec City		20	
Maritime Provinces		10	
	1,320 (80%)	325 (20%)	1,645 (100%)
TOTAL	8,635 (81%)	2,340 (19%)	10,975 (100%)

2. Winnipeg - The Pas - Thompson - Churchill[2]

Between/and	En-Route	Off-Route	Total
Churchill			
Alberta		280	
British Columbia		110	
Manitoba			
Brandon		5	
Dauphin		30	
Flin Flon		80	
Lynn Lake		155	
The Pas	885		
Thompson	1,650		
Winnipeg	7,195		
Maritime Provinces		75	
North West Territories			
Eastern Arctic		30	
Central Arctic		25	
Western Arctic		145	
Ontario		1,210	
Quebec		285	
Saskatchewan		195	
TOTAL	9,730 (79%)	2,625 (21%)	12,355 (100%)

(1) O & D do not include trips on PWA service via Yellowknife.

(2) Based on major routings in 1969, according to published schedules.

3. (Calgary) - Edmonton - Yellowknife - Norman Wells - Inuvik - Cambridge Bay

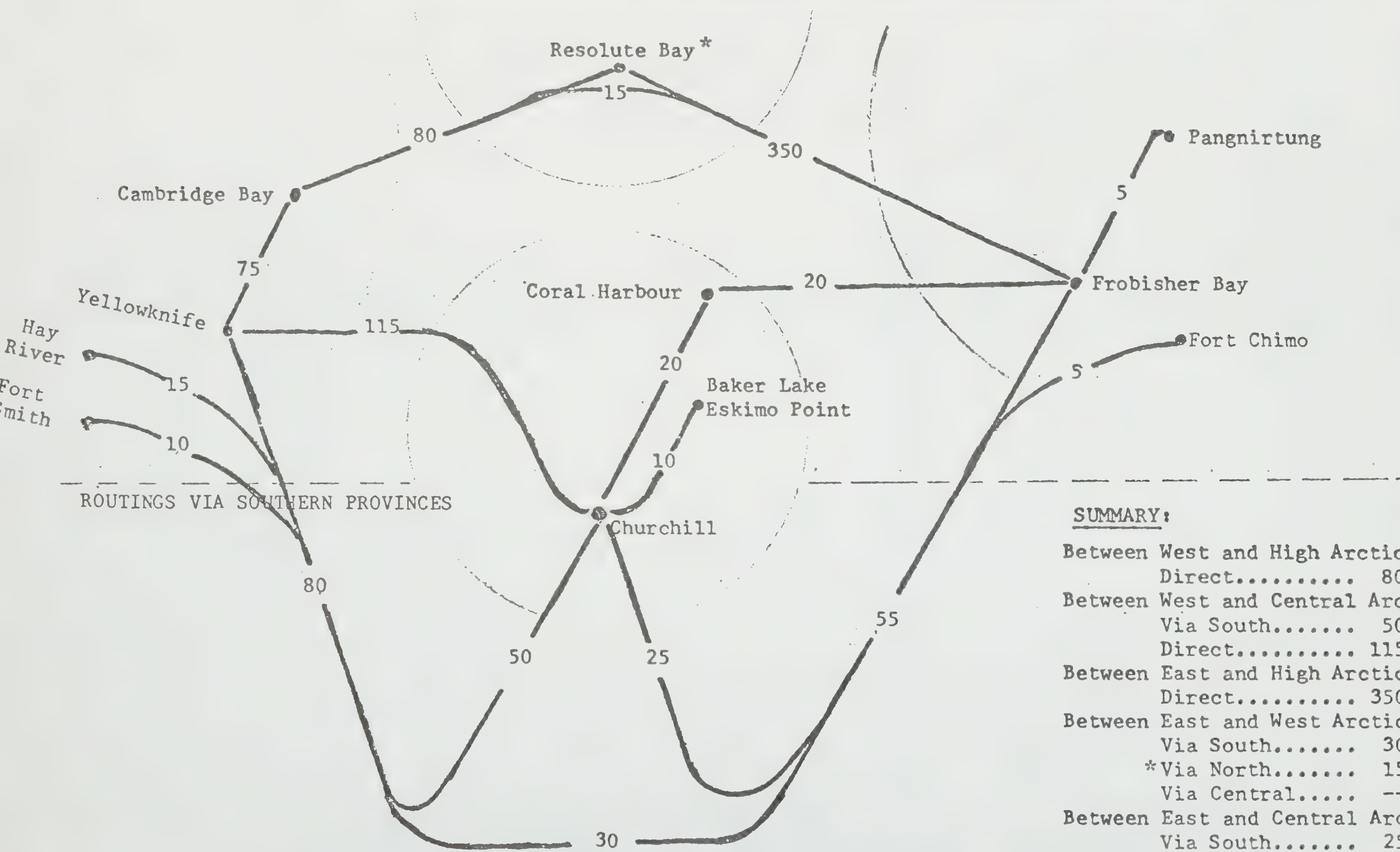
Between/and	En-Route	Off-Route	Total
Cambridge Bay			
Alberta			
Calgary	20		
Edmonton	850		
Rainbow Lake		10	
British Columbia		25	
Manitoba		10	
North West Territories			
Fort Simpson		10	
Fort Smith	110		
Hay River	30		
Yellowknife	505		
Ontario		40	
Quebec		20	
Yukon		10	
	1,515 (92%)	125 (8%)	1,640 (100%)
Inuvik			
Alberta			
Calgary	470		
Edmonton	5,005		
Fort McMurray	15		
Grand Prairie		10	
Lethbridge		5	
British Columbia		255	
Manitoba		50	
Maritime Provinces		5	
North West Territories			
Fort Smith	260		
Hay River	395		
Norman Wells	680		
Yellowknife	1,695		
Other, MacKenzie District		230	
Ontario		590	
Quebec		80	
	8,520 (87%)	1,225 (13%)	9,745 (100%)

(Calgary) - Edmonton - Yellowknife - Norman Wells - Inuvik - Cambridge Bay (Cont'd)

tween/and	En-Route	Off-Route	Total
rman Wells			
Alberta			
Calgary	125		
Edmonton	1,745		
British Columbia		30	
Manitoba		10	
North West Territories			
Fort Smith	135		
Hay River	90		
Yellowknife	530		
Other, MacKenzie District		60	
Ontario		50	
Quebec		20	
	2,625 (93%)	170 (7%)	2,795 (100%)
llowknife			
Alberta			
Calgary	720		
Edmonton	17,745		
Fort McMurray	55		
Peace River	10		
Rainbow Lake		30	
British Columbia		1,910	
Manitoba		775	
Maritime Provinces		80	
North West Territories			
Fort Smith	3,685		
Hay River	4,140		
Resolute Bay	50		
Other:			
MacKenzie District		1,090	
Western Arctic		10	
Central Arctic		10	
Eastern Arctic		40	
Ontario		1,560	
Quebec		205	
Saskatchewan		310	
Yukon		15	
	26,405 (81%)	6,035 (19%)	32,440 (100%)
TOTAL	39,065 (84%)	7,555 (16%)	46,620 (100%)

TABLE III

PASSENGFR TRAFFIC FLOW BETWEEN THE WESTERN, THE CENTRAL, THE HIGH, AND THE EASTERN ARCTIC, GENERATED EXCLUSIVELY WITHIN THESE AREAS IN 1969.



SUMMARY:

Between West and High Arctic
Direct.......... 80
Between West and Central Arctic
Via South....... 50
Direct.......... 115
Between East and High Arctic
Direct.......... 350
Between East and West Arctic
Via South....... 30
*Via North....... 15
Via Central..... --
Between East and Central Arctic
Via South....... 25
Direct.......... 20

POLICY ASPECTS OF NORTHERN TRANSPORTATION & FACILITIES

BY: MR. R.A. MORRISON
Vice-President, Transair Limited

It is a pleasure and an honour for me to be invited to participate in Canada's first Arctic Transportation Conference. I'm sure we'll all agree that the calling of this conference is certainly not premature.

Before beginning I would like to commend the initiative of the Federal Government, particularly Don Jamieson and his Department for taking this initiative and providing the transportation industry and the user industries and organizations with a vehicle for exchanging ideas, opinions, plaudits and criticisms on the effectiveness of the present transportation system and the requirements of the future. It is this kind of interchange of information that is essential if we in the industry are to hope to provide what is described in the objectives of this Conference -- "an efficient, economic and adequate transportation system".

In this panel, I was assigned the job of discussing, from the carrier's standpoint, the physical facilities existing at present and required for the future. I decided, however, in light of the program which provided yesterday a very detailed and effective discussion of the technical facilities, their use and cost, in Bob Engle's panel that it might be less repetitious and more useful to discuss in broader brush terms with the policy aspects of transportation

hardware or infrastructure and the overall importance of adequate facilities to meeting the objectives of this Conference and, I would hope, all participants.

It is a common misconception -- not at all discouraged by the operators -- that air transportation, unlike railways or trucking operations, requires no rails, no highways, no fixed facilities to fulfill it's function. This is, of course, patent nonsense. Airlines are heavily dependant upon an infrastructure of airfields, weather data, en route and terminal navigation aids. This infrastructure is always expanding, requirements are becoming more and more demanding, to keep pace with the technological evolution of the air industry.

Government policy, in the past as in the present, has determined that the basic infrastructure can best be provided by public funds on the theory that transportation, as it was 100 years ago, is fundemental to attainment of national goals and objectives and to the well being of the national as a whole.

The arguments start, as they did in MacDonald's day, when the allocation of the nation's limited resources is made. We are in Yellowknife this week I submit, not to convince Government that the upgrading of facilities and expansion of air services in the North is desireable -- all Governments are in favour of motherhood -- rather we must direct our attention towards pointing out to the

Government how their assistance and participation in expanding their involvement in the provision of transportation facilities in the North can be of national benefit and of direct benefit to the residents of the North.

We have heard a great deal at this Conference about the technical problems of upgrading present facilities in the Arctic, we have heard about the staggering cost of establishing and maintaining these facilities. I believe we must also focus on what the lack of these facilities cost the nation and the people of the North, and the savings that can be attained through provision of improved facilities.

I speak from the position of a carrier that has -- to all intents and purposes -- been in the position of the dog at the dinner table -- getting only scraps from the feast above. Transair serves the Keewatin District, an area of the North that is lamentably far behind the neighbouring areas of the Eastern Arctic and especially the Mackenzie River Valley. The lack of facilities and services has tended to accelerate the development of one particular area of the Arctic while placing staggering obstacles in the way of the development of the Keewatin.

Air Carriers in the North have, I submit, proven themselves to be responsible citizens of the Arctic. They have pioneered services at great cost and in many cases human sacrifice; they have wheedled and cajoled governments into

providing fundemental facilities that have gradually permitted the carriers to improve equipment, maximize efficiency and substantially reduce costs to residents of the North and those doing business in the North. We have heard Kurt Peiffer of Nordair outline his Company's success in reducing transportation charges to and from the Eastern Arctic, Pacific Western has been able t to reduce transportation costs by as much as 75 percent over its route network. Transair has also reduced costs, but on a less massive scale. Why?

We must analyse how these economies have been introduced and how they were achieved. In both Nordair's and PWA's case, the significant reductions followed the introduction of modern, sophisticated and expensive equipment -- basically the Boeing 737-200C, but in PWA's case also the Hercules transport. A necessary prerequisite to the introduction of these aircraft was the provision of basic landing facilities and navigational aids. I stress the term "basic" because, as envious as I am of the facilities now available at Yellowknife, Inuvik, Norman Wells, Frobisher Bay and Resolute, they are still minimum facilities, with the possible exception of Yellowknife.

In the Keewatin, there is only one runway capable of handling a Boeing 737 and that is Coral Harbour. The main population and supply centres of Baker Lake and Rankin have bare minimum facilities now for twin turbo-prop aircraft, and these are rugged. It was only in 1970 that Transair was able to

introduce turbo-prop service into this area. While the arrival of this equipment is definitely an improvement over the DC-3 operations of the past, it still does not permit us the economies of scale offered by Boeing 737 for mixed cargo-passenger service, or the Argosy freighter for all-cargo services.

To give you an idea of the cost penalties created by the lack of adequate facilities, one must look at the relative ton-mile costs of the various types of equipment. The venerable DC-3 can handle cargo at a rate (assuming charter rates) of 80 cents a ton-mile. A Boeing 737 can handle it at a cost of approximately 20 cents a ton-mile, while the Hercules or Argosy handles freight at approximately 17 cents per ton-mile. Using a 400-mile stage length the cost differential works out as follows. To deliver 4000 pounds of cargo it would cost on these figures, \$640.00 in a DC-3, \$160.00 in a B-737, and \$136.00 in an Argosy or Hercules.

Regrettably, carriers themselves are powerless to introduce this more productive and lower cost service without the support of the federal and territorial governments in developing the basic infrastructure of runways, airport facilities and services and navigational aids both terminal and en route. We have seen the speed at which basically economic but nevertheless adequate facilities can be developed in this hostile environment when facilities are required. All main drilling sites on the Arctic Islands have runways adequate for heavy transport aircraft

like the Argosy and Hercules -- virtually all have NDB's and of course, runway lighting. All have been provided in record time by the Oil Companies themselves.

I don't want to criticize existing transport standards, however, perhaps the federal government could take into consideration the equipment and methods used by the oil industry in developing facilities at minimum cost. I believe that all operators in the North accept the fact that, conditions being what they are, it may well be unreasonable to expect the same standard of runway, nav aids and terminal facilities that exist in southern Canada. This is not to suggest that safety must be compromised, but in some cases it would be better to have a substandard airstrip for an alternate than to have no airstrip at all.

Who pays?

If fully adequate facilities are provided either the identifiable users pay in full -- and that means not only the entrepreneur but also the northern resident -- or the general taxpayers of Canada pay. If user charges are levied on a fully allocated basis it means that the cost of living in the Arctic skyrockets, it means that potential industrial resource development is severely retarded, it means continuation of the penalties of isolation. On the other hand if these costs are distributed on a wider base it means a distribution of the penalty of distance, isolation and expense for those living in and developing the

Arctic.

I want to stress that I am not suggesting the transportation industry is asking for a "free ride". The four carriers sitting on this platform have today, and this is perhaps conservative, an investment in capital equipment and facilities largely committed to serving and developing the North of well in excess of fifty million dollars. When the investments of all other carriers operating in the North are considered it is probably not unrealistic to suggest that our industry has a $100 million investment in the Arctic. When compared with the governments' investment in the Arctic I don't believe you will find any great imbalance or disparity.

Transportation, since the founding of this nation, has been a necessary instrument of public policy and a public service in itself, that has been and is more so today a part of the essential fabric of the nation. Originally the railway was the primary designated national transportation vehicle. Under the umbrella of government regulation and financial assistance Canada was girded with steel with the driving of the last spike in the Canadian Pacific Transcontinentla Railway line in 1885.

The provision of a national transportation system was considered so essential that when British Columbia joined Confederation in 1871 it was stipulated as a condition of contract, or perhaps more appropriately as the dowery, that Canada would

complete the transcontinental railway within ten years.

Remarkably, that promise was kept within four years of the original target. Mind you it took the substantial financial assistance of the federal government and the ingenuity and entrepreneur-ship of private enterprise to do it.

There were plenty of doubting-Thomases in 1880 and certainly the allocation of $25 million dollars at that time by the Government of a new-borne nation to the development of a national transportation system was decried by many. The Easterners, who certainly represented the vast majority of the population,pointed to the non-existant population of the sprawling Prairies, the lack of known resources and the seemingly impossible technical and engineering difficulties to be overcome as simply not justifying such a staggering capital committment by the Government.

What followed? Rapid population of the new territories opened up by the construction of the new railway; the emergence of a world recognized agriculture industry and the accelerating development of resource industries. Canada, which before had existed as virtually totally-isolated pockets of population with, in many cases, a far greater community of interest with its southern neighbours, was witness to the awakening of a national identity, a national purpose and national objectives.

I want to suggest to you today that today, one century later, we stand on the threshold of as great a frontier, as great a challenge and opportunity as was presented to Canadians 100 years ago. Can we hope to call ourselves a nation in the 20th Century if we do not seize the initiative and with the same vision, tenacity and committment as was displayed by our forefathers provide the resources to builf a nation that will not only be 5000 miles wide, but 5000 miles deep.

These objectives cannot be realized by a rigid adherence to cost-benefit analysis over the short term~~,~~;it cannot be achieved without a clearly stated policy of national objectives; it cannot be achieved by the transportation idustry without the resources of the national government; and I suggest, the federal government cannot impliment a national policy for the Arctic without the full support of this industry.

The federal government must accelerate the provision of a basic infrastructure for the development of a co-ordinated and efficient transportation system for the Arctic and for the delineation of a long range statement of goals and objectives supported by a vehicle to oversee the implimentation of programs to meet these targets.

The transportation industry, on its part, must accept responsibility for providing the equipment required to meet

these goals and for providing the advance planning support, technical and commercial expertise to support the efforts of whatever vehicle may be created by Ottawa to impliment its policies.

The resource industry must accept the need for far greater advance planning snd programming by governments and the transport industry to meet their needs. This will require a high degree of confidence by all parties and a far greater disclosure than has been evident in the past.

All three, government, the resource and transportation industries have to accept the fact that to a degree never before apparent, the impact of sociological and ecological change must become fundemental to all planning and programming.

I firmly believe that the only way all these factors can be weighed, the only way that a national transportation system of the North can be achieved is through the creation of what might be called the Arctic Transportation Agency. I hasten to add that I am not suggesting another government department, nor do I believe that this Agency should have any regulatory, policy making or executive function. I conceive this Agency to be provided with full-time facilities and staff to provide a means of consultation and coordination. This organization, if it was to be effective in my view, would have to be supported by both government and industry with an Executive Council composed of federal, territorial and industry

appointees. The industry appointees would be drawn from both the transportation and user industries.

This organization, given wholehearted support by government and industry, would provide the vehicle for achieving the goals of this Conference and of every participant here --- "the orderly social and economic development, compatible with protection of the environment, through the provision of an efficient, economic and adequate transportation system."

In closing I would like to quote Professor Frank Underhill, in defining a nation, when he wrote:

"A nation is a body of people who have done great things together in the past and who hope to do great things together in the future."

Our job is to imbue all Canadians with the spirit of excitement, challenge and opportunity that is evident throughout this Conference. To present them with the Arctic as the most dynamic sector of Canada's future.

AIR TRANSPORT IN THE CANADIAN NORTH

BY: MR. MAX WARD
President & General Manager, Wardair Canada Ltd.

THE OBJECTIVE OF THIS CONFERENCE IS TO DISCUSS NORTHERN TRANSPORTATION IN THE 1970's FOR THE PURPOSE OF CONTRIBUTING TO ORDERLY SOCIAL AND ECONOMIC DEVELOPMENT, COMPATIBLE WITH PROTECTION OF THE ENVIRONMENT, THROUGH THE PROVISION OF AN EFFICIENT, ECONOMIC AND ADEQUATE TRANSPORTATION SYSTEM.

HAVING IDENTIFIED THE OBJECTIVE, AND IN ORDER TO ESTABLISH A BENCH-MARK, THE QUESTION OF THE ADEQUACY OF OUR PRESENT TRANSPORTATION SYSTEM MUST BE CONSIDERED ... AND I CONFINE THIS REPORT TO MY ASSIGNED SUBJECT, "AIR TRANSPORTATION IN THE CANADIAN NORTH".

<u>FIRSTLY</u>, IS A TRANSPORTATION SYSTEM ADEQUATE SHOULD IT BE ABLE TO PERFORM A TRANSPORTATION TASK THAT IS ASSIGNED ACCORDING TO THAT TRANSPORTATION SYSTEM'S ESTABLISHED CAPABILITY? SHOULD THIS BE THE CRITERIA OF AN ADEQUATE TRANSPORTATION SYSTEM, I WOULD SUGGEST THAT OUR PRESENT AIR TRANSPORTATION SYSTEM IS ADEQUATE. TO MY KNOWLEDGE, THE REQUIREMENT TO MOVE PASSENGERS AND FREIGHT IN THE NORTH IS BEING MET.

<u>SECONDLY</u>, WHAT IS AN ADEQUATE TRANSPORTATION SYSTEM WHEN WE COUPLE-IN THE ADDITIONAL OBJECTIVES: "AN EFFICIENT AND ECONOMIC TRANSPORTATION SYSTEM"? EFFICIENT AND ECONOMIC ARE, OF COURSE, BOTH RELATIVE TERMS; HOWEVER, IS A TRANSPORTATION SYSTEM ADEQUATE SHOULD IT <u>NOT</u> BE ABLE TO PERFORM AN ASSIGNED TRANSPORTATION TASK AS EFFICIENTLY AND ECONOMICALLY AS SUCH TASKS ARE PERFORMED ELSEWHERE AS IN THE MORE SOUTHERNLY AREAS OF CANADA?

I WOULD SUGGEST OUR PRESENT NORTHERN AIR TRANSPORTATION SYSTEM IS NOT ADEQUATE SHOULD THIS COMPARISON BE THE CRITERIA OF AN ADEQUATE TRANSPORTATION SYSTEM - AND I BELIEVE THE COMPARISON IS JUSTIFIED.

IN COMMERCIAL OPERATIONS THE JUSTIFICATION FOR AIR SERVICES IS PREDICATED ON DEMAND - AND BY COMPARISON, THE DEMAND WHICH HAS ESTABLISHED LOW TRANSPORTATION RATES IN THE SOUTH DOES NOT EXIST IN THE NORTH. HOWEVER, THE AIR TRANSPORTATION CAPABILITY THAT EXISTS IN THE SOUTH OF CANADA COULD ALSO SERVE THE NORTH AS AN ADDITIONAL MARKET IF PERMITTED TO DO SO.

THE CONTROLLING FACTOR IN SERVING THE NORTHERN AIR TRANSPORTATION MARKET WITH HIGHLY EFFICIENT JET FREIGHTER AIRCRAFT IS THE AVAILABILITY OF SUITABLE AIRPORTS.

TRANS-SHIPMENT, HUB AIRPORTS SUCH AS RESOLUTE BAY AND INUVIK WOULD BE LOGICAL DESTINATIONS FOR SUCH AIR SERVICES. NEITHER POINT IS SERVED BY YEAR-ROUND SURFACE TRANSPORTATION AND EACH OF THE DESTINATIONS HAS ATTAINED CONSIDERABLE IMPORTANCE IN RESOURCE DEVELOPMENT, AS WELL AS BEING STRATEGICALLY LOCATED FOR NATIONAL DEFENCE.

BY ESTABLISHING AIRPORTS AT INUVIK AND RESOLUTE BAY TO STANDARDS COMPARABLE TO SPECIFICATIONS DESIGNATED FOR SOUTHERN-CANADIAN AIRPORTS, AND WITH RUNWAYS CAPABLE OF ACCOMMODATING HEAVY JET FREIGHTER AIRCRAFT, DISTRIBUTION CENTRES FOR COMMERCIAL ENTERPRISES WILL DEVELOP - ATTRACTED BY AN EFFICIENT, ECONOMIC AND ADEQUATE TRANSPORTATION SYSTEM. WITHOUT ELABORATING, THE AIRPORTS WILL ALSO PROVIDE ATTRACTIVE FACILITIES FOR NATIONAL DEFENCE.

WHICH COMES FIRST, THE TRANSPORTATION "REQUIREMENT" OR THE TRANSPORTATION "CAPABILITY"? AT THIS POINT IN THE DEVELOPMENT OF THE NORTH, I WOULD SUGGEST THAT TRANSPORTATION CAPABILITY TAKE THE LEAD AT THESE TWO CRITICAL LOCATIONS.

THE INFLUENCE OF GOVERNMENT LEADERSHIP IN NORTHERN DEVELOPMENT HAS BEEN ABLY DEMONSTRATED AT INUVIK. ALTHOUGH THIS ARCTIC CENTRE CAME INTO BEING AS A GOVERNMENT TOWN, IT HAS BECOME A VERY IMPORTANT DISTRIBUTION POINT FOR RESOURCE DEVELOPMENT WITHIN ITS AIRPORT LIMITATIONS AND HAS A GROWING SEGMENT OF PRIVATE INDUSTRY.

THE RULES THAT APPLY TO THE JUSTIFICATION FOR GOVERNMENT-FINANCED FACILITIES IN SOUTHERN CANADA CANNOT BE APPLIED TO THE ARCTIC. WE WILL WAIT A LONG TIME BEFORE THE POPULATION OF RESOLUTE BAY BUILDS TO THE LEVEL REQUIRED IN SOUTHERN CANADA TO JUSTIFY AN EXPENDITURE FOR AN AIRPORT FACILITY SUCH AS IS SUGGESTED, IF POPULATION BE THE CRITERIA. A COMPLETELY EQUIPPED, ALL-WEATHER AIRPORT CENTRED STRATEGICALLY IN THE ARCTIC AT RESOLUTE BAY WOULD INSTILL TRANSPORTATION STABILITY IN THAT VAST AREA, REDUCING PROBLEMS OF AIR SAFETY AND THE SEASONALITY OF DEMAND WHICH HAS LONG PLAGUED THE ECONOMICS OF AIR TRANSPORTATION IN THE NORTH.

WE HAVE ALL HEARD GREAT THINGS ABOUT HOW AVIATION HAS LONG BEEN RECOGNIZED AS THE KEY TO OPENING UP THE NORTH, AND HOW THE AVIATION PIONEER ADAPTED HIS MACHINE TO SKILLFULLY PERFORM FEATS IN PRIMITIVE OR RELATIVELY PRIMITIVE MACHINES. BUT THIS IS 1970! WE CAN READILY DELIVER 40 TONS OF FREIGHT FROM CANADA TO LONDON, ENGLAND IN 7 HOURS -- AND COULD PERFORM SIMILAR TASKS IN NORTHERN CANADA @ 12¢ PER TON MILE.

AIR TRANSPORTATION IN THE NORTH HAS ALWAYS BEEN A COMPROMISE BETWEEN AIRCRAFT OPERATING COSTS AND THE ABILITY OF THE AIRCRAFT TO COPE WITH PRIMITIVE GROUND FACILITIES. THE INDUSTRY WILL HAVE TO CONTINUE TO LIVE WITH THIS EQUIPMENT COMPROMISE - HOWEVER, IT NEED NOT CONTINUE TO DOMINATE AIR TRANSPORTATION IN THE NORTH.

IF THE NORTH IS TO DEVELOP, IT MUST HAVE AN INJECTION OF THE AIR TRANSPORTATION ECONOMICS ENJOYED IN SOUTHERN CANADA. THIS CAN ONLY BE ACHIEVED BY ESTABLISHING GROUND FACILITIES THAT MEET THE REQUIREMENTS OF THE AIRCRAFT.

AIR TRANSPORT AND NORTHERN DEVELOPMENT
Address By: Robert Engle
President Northwest Territorial Airways Ltd.

DEVELOPING NEW TRANSPORT GRID IN THE NORTH

Since our discussions together deal with all modes of Northern transport, I would like to direct my initial comments this afternoon to the relationship of air to other modes of transport. Northerners travel by air. While air transport is the dominant Transport medium in the North, we recognize there is a growing range of competitive services. Rail and highway developments have reached Great Slave Lake. Yellowknife became, as we know, the northern terminal of ground transportation with the extension of the Mackenzie Highway in 1959. Unknown large future mineral deposits may push the terminal even further North. This past summer the Mackenzie Highway was extended to reach Fort Simpson on the Mackenzie River. The development of a gas pipeline down the Mackenzie will surely be paralled by a road system. The recent announcement by the Honourable Minister has advanced the completion date of the Dempster Highway from the Yukon interior to the Mackenzie Delta, giving road access for the first time to this resource development area.

The Mackenzie River navigation services are now being improved in reliability and speed. Improved loading and unloading systems will be developed. Sea navigation along the Arctic Coast is likely to be dramatically transformed because of the technological advancements in ship design, increased experience in operations and conditions. Additional staging areas, such as Resolute Bay, Sherrard Bay and Johnson Point in the Arctic Islands are underway. Ground vehicles, such as the Hovercraft, are at the initial stages of practical development. These developments added together already form the basis of a new transport grid for the North.

MAIN OBJECTIVE IS NORTHERN DEVELOPMENT

But enough about the other developments. My business is air transport. I am disturbed this afternoon that there is a strong possibility that through regulatory rigidity, air transportation may not be able to fully exploit its inherent advantages to the benefit of Northerners and Northern development. We do not have the same inter-modal competition that exists in the South. And this clearly will not change in

the North during the 70's. Our objective is to accelerate Northern development. This is our first goal. This was the purpose, I believe, when the Minister of Indian Affairs and Northern Development, and the Minister of Transport, sponsored this conference. So all the policies and ideas we've been talking about, navigational aids, development of new modes, airport improvement, regulations of air carriers, should all be serving the major goal of Northern development.

DRAMATIC INCREASE IN NORTHERN DEMAND

Today, air transport trends show improved economic and competitive abilities. Look at air cargo in the North in the last two years. Mr. Courtney in his statistics has shown an increase of 125% in large aircraft air freight from 1968 to 1969 in the North alone. And we are just at the threshold of even greater demand. The pipeline plans or any strike, be it oil, gas or mineral, will materially increase further the demand for new uplift capacity.

TIME FOR PHASED COMPETITION

So it's time that we had some phased competition that can only result in reduced cost to the North. It's time that Northern air cargo service stopped subsidizing Southern routes. I'm not creating a new theory here. Let me read you something that sets out our position as Northerners interested in the development of the North and asking for only a share in our own development here.

"It is hereby declared that an <u>economic</u>, efficient, and adequate <u>transportation system</u> making the best use of all available modes of transportation at <u>the lowest total cost</u> is essential to <u>protect</u> the interest of <u>the users of transportation</u> and to maintain the economic well being and <u>growth of Canada</u>, and that these objectives are most likely to be achieved when all modes of transport are able <u>to compete</u> under conditions ensuring, that having due regard to National policy......" and so forth.

Those are not my words. Those are the words of the Parliament of Canada outlining a National Transportation Policy passed in 1967. The key phrase is to foster the economic growth of Canada at the lowest cost to the users.

COMPETITION COULD LOWER COSTS TO NORTHERN CONSUMER

We agree that each transport mode should expand according to its inherent advantages. In the Northern context this implies continuation and increase in the provision of basic facilities such as airports, aids to navigation, harbours, research and development of new transport media. It also implies planned introduction of a greater degree of competitive freedom if we are to quickly achieve faster growth at a lower cost to the consumer in the North. In this way, air transport policy by air transport regulation on one hand will not defeat the policy of Northern development on the other. Rather these policies can be co-ordinated to achieve the major objective of Northern development.

DEVELOPING NEW NORTHERN MARGINAL MARKETS

It means that economically justified expansion by air carriers should be encouraged rather than discouraged. It means that carriers who have shown an ability to develop marginal markets in the North should not be stunted by restrictions and barriers in their business drive to improve operating methods, better facilities and thereby combat rising costs. This type of growth, encouraged by a sensitive policy of air regulation, is probably the most important factor in lowering, or at least holding stable, operating costs to the benefit, in real dollar savings, to the consumer in the North.

LIMITING FOREIGN CARRIERS IN THE NORTH

Let me ask a question. Is it in the interest of the long term development of transportation services in the North to allow foreign carriers, contract operators or short term leased aircraft to meet the so-called peak requirements. I say no. These precious and growing revenue dollars should go

to building viable transport operations in the North, if there are people in the North willing to risk their own dollars. This can only help Northern development. To my mind, the best way of guaranteeing aircraft capability to meet peak requirements is not to bring aircraft from outside the country but to allow Canadian carriers committed to the development of air transport in the North to serve this peak demand and then during the balance of the year utilize the additional capacity. This can only bring down the cost of air transport in the North.

SPREADING PEAK DEMAND IN THE NORTH

Today the northern operator has demonstrated with availability of aircraft and improved hangar facilities, he can operate 12 months of the year successfully and spread traditional peak demands. Given large government involvement in the area, it should be possible to reschedule some airlift operations to spread these peaks even further. With the growth of longer shipping seasons, with the growing range of government activities, with proper planning, the benefits to the user of a more even flow of air work spread throughout the year can be achieved. I say that in the North supplementary carriers should be defined in a way that will help, not hinder, this type of Northern development. Air carriers, and for that matter, all transport operators in the North, should be closely drawn into forward development planning for the region. This should involve the regulatory agencies as well. With better lead time, with better information of future developments, with better co-ordination of resource development, the planning risks of the carrier could be reduced, while their ability to meet and even develop new demands can be realized.

NEW STEPS TO IMPROVE NORTHERN SERVICE BY NORTHWEST TERRITORIAL AIRWAYS

Let's look ahead. I see the rapid development of new air routes - specifically an east-west lateral route North of 60.

1) This month our company has made an application to the Canadian Transport Commission to extend its schedule service east of Yellowknife to Baker Lake. This will interline

with the services of Transair to Churchill and points in between - closing the east-west gap to Hudson Bay.

2) Northwest has made a further application to add the BH 125 jet aircraft at Yellowknife to improve the services in the North.

3) We are now implementing that part of the recent decision of the Air Transport Committee by adding a Douglas DC 6 A/B cargo/passenger aircraft for our service here at Yellowknife.

REDUCING COMPETITIVE RESTRICTIONS

It's clear to me that the regional air carrier policy during the last half of the 1960's established a policy framework to allow regional carriers to push forward with new equipment and expand their services. But there was only one line in that policy about the North. What was good South of 60 during the 1960's for air transport is not adequate North of 60 in the 1970's. If further restrictive conditions are established that would result in greater disadvantage to Northern air carriers, specifically in the carriage of air of air cargo, this can only end in increased levels of cost to the consumer. We have fought to add a Hercules to our Northern base of operations. This, to my mind, would be good not only for the regional carrier, but good for Northern development. This battle is not yet finished.

As a Northern operator, I am gratified that the problems of our Northern community are getting the important attention that this conference signifies.

VOLUME 3

OTHER PAPERS:

ALTERNATIVES OPEN TO THE GOVERNMENT OF CANADA WITH RESPECT TO AIR POLICY IN THE NORTH

BY: DR. T.G. HOW
Senior Ministry Executive - Special Projects,
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NTRODUCTION

In today's parlance, "planning, programming and budget ystems" are being emphasized as the proper method for making anagement decisions. Included in this method is the development f alternatives to meet required objectives. The cataloguing of lternatives is essential in this process and this discussion is rimarily a listing of the principal alternatives with respect to ir policies for the North. The paper is not intended to indicate hich alternatives should be followed but instead to present them or the purpose of further discussion.

There are three broad, but basically independent, areas of ctivity within which the Federal Government can act to carry out ny of its alternative air policies. These are in the area of afety, the area of economic regulation of competition (including he provision of subsidies) and the area of support facilities. his paper will suggest alternatives and consider some of the roblems related to applying them as they pertain to each of these hree areas.

The basic alternatives in each of these areas can be examined n relation to the Government's present policies as applied in outhern Canada. Nine alternatives can be thus identified, as epicted below, from which three relatively independent courses of ction might be taken.

	Government Policy as compared to that prevailing in Southern Canada		
	A	B	C
afety	same	higher standards	lower standards
conomic Regulation	same	less restriction	more restriction
upport Facilities	same	less participation	more participation

This paper will consider Alternatives A, B and C as they relate first to safety, then to economic regulation and finally to support facilities.[1]

AIR SAFETY IN THE NORTH

Before analyzing the various alternatives which the Government faces in pursuing a policy for safety of Northern aviation, it is emphasized that when the risk in aviation of damage to life or property is reduced, the feasibility of flight is increased. Thus the ultimate benefits from improved safety standards are not only the saving of life or property which results but also, and this is of greater practical consequence, the opportunities which are created for more flights and fewer delays. Many proponents of arctic air transport would say this in another way - "Arctic flights are not more hazardous, they are more restricted". In the following discussion, therefore, higher standards of flight safety will actually, in most cases, constitute a less restrictive policy towards northern air transport and vice versa.

Present standards with respect to air safety in the North are identical with those in Southern Canada.[2] They concern principally airworthiness standards, pilot qualifications, criteria for the establishment of navigational aids and criteria for airports. Because of the greater density of established communities in the South, there is no doubt a more dense network of airstrips, communication facilities, weather stations and navigational aids. This might imply that safety standards in the South are higher than in the North but the greater density is, instead, the result of the greater traffic requirements in populated areas and not the result of different criteria for the establishment of specific facilities.

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(1) The inter-modal relationships which might affect the selection of suitable alternatives are not developed in this paper. For instance, the construction of additional airstrips might be obviated by the development of surface transport facilities, or the subsidization of a particular air service might be avoided if marine transport facilities were upgraded.

(2) In one respect, safety standards are somewhat higher in the North in that in flight over isolated areas there are additional requirements concerning aircraft emergency equipment.

Alternative A (same safety standards as in Southern Canada)

The first alternative open to the Government is to continue with uniform national standards throughout the country, North and South. The arguments in favour of maintaining this policy are fairly convincing.

First, the present airworthiness standards and pilot requirements have proven satisfactory for Northern operations and there is no indication that safety in the North is in jeopardy as a result of this. In general, operators accept the present standards and have never used the argument that they should be changed to meet extenuating circumstances in Arctic areas.

The Government could also present a reasonable case for maintaining present criteria and standards with respect to aviation facilities. These criteria are based primarily on the frequency of flight and it would be necessary to present a case for, say, an ILS at Resolute Bay even though the number of IFR aircraft arriving at that airport is less than that arriving at some non-ILS airports in the South. Similarly runways should be built to the same zoning clearances. For example at Fort Simpson operators have the right to expect that flightways will be cleared to the same standard as they are, say, at Thunder Bay.

The adequacy of the present network of airports, and the policy under which they have been constructed and operated, can be strongly defended. It represents a federal investment of \$76,000,000 and an annual operating cost of \$4,500,000. In view of these figures, the Canadian taxpayer and the Government might well take the position that enough is already being spent in this area. Any further expansion of the airport network, even under present criteria, might have to be financed out of additional user charges. The same situation prevails with respect to en route facilities.

Alternative B (higher safety standards)

The next alternative open to the Government is to establish in the North increased standards of flight safety above those that prevail in Southern Canada. There is little evidence to indicate that the present airworthiness standards need to be made more rigorous. A case might be presented that failures in aircraft frame or engines result in more serious emergencies in the North than in the South but it is expected that any benefit-cost study would not be successful in justifying such a step. A more logical argument might be presented for the need to demand

higher pilot qualifications for Northern operations where aeronautical competence appears desirable, particularly where a great deal of VFR flying is involved. In general, the industry itself has set its own standards with respect to special pilot qualifications and they appear to be satisfactory.

One way to achieve a higher degree of flight safety is through the introduction of multi-engined aircraft in place of single or twin-engined equipment. The economics of specific operations dictate the type of aircraft to be used. There appears to be some justification for a Government policy which would encourage the use of multi-engined aircraft in Northern Canada. This might be done through direct operating subsidies, but possibly more readily through the provision of adequate runways and landing aids.

In the case of navigational facilities for the North, there is considerable pressure on the Government to apply special criteria to increase the safety of flight by increasing the density of the networks relating to navigational aids, air-ground communications, airports, weather observations and weather forecasts. The basis for these requests relate to the Northern environment and the difficulty of VFR flight in the North, the problems of shortwave communications, the long distances between aeradio stations, the unknown weather conditions and lack of airstrips. (In the latter case it is significant to point out that the requests for adequate airports have not been based so much on safety per se, but rather on the need for facilities to serve a particular community or area.)

To improve the density of weather and communication facility networks, the Government would be required to ease its criteria with respect to their establishment in the North and recognize that elements other than frequency of flights using them should be established. Such a change would, of course, result in increased capital and operating costs. The latter might be reduced by the use of automated devices remotely controlled from existing aeradio stations. This is a challenging program for the proposed Arctic Transportation Administration to examine.

A frequent demand presented to the Canadian Government is for the establishment of new airports to service Northern communities. The Ministry of Transport presently has a well-defined policy with respect to the construction and operation

of airports and it is applied to Northern areas in the same way as it is in the South[3]. Its special policies with respect to "remote" airports and "resource" airports are of particular interest to the development of the North. In Southern Canada the Ministry of Transport expects provincial governments or private industry to share in the cost of these airports but, in the North, the absence of provincial resources has resulted in the Department of Indian Affairs and Northern Development taking the major role in the development of remote and resource airports. The Ministry of Transport is re-examining its policy for airport assistance in the more populated areas and its new policy with respect to airports in the North will be left to be generated by the new Arctic Transportation Administration.

The necessary network of airports is one of the most important aspects of the development of transportation in the North. A number of factors are involved in identifying the need for such new airports. The most important of these are the decisions made by the Air Transport Committee in licensing new air services and the rate at which resulting traffic volume develops. In order to avoid the construction of expensive airports which might later turn out to be white elephants, the Federal Government now takes the position that the traffic which warrants the proposed airport construction must be assured for the foreseeable future.

An essential point to be considered if there is to be an increased network of facilities and airports in the North is the source of additional funds which will be required. User charges would, in all probability, have to provide a reasonable portion of these.

There have been and still are a number of airports developed in the North for military purposes. Historically, many of these have been turned over to the Ministry of Transport and are still being operated. Their continued operation is justified because of the scheduled air services using them. A number of DEW Line airports are still operated for military purposes but have become key terminals for some civil air operations. If the military requirement for these airports is reduced, their possible transition to civil airports will have to be considered. The Government will then be squarely faced with choosing one of the various alternatives discussed in this paper. Any solution should be taken in the light of a clearcut policy on the co-ordination of military and civil air requirements in the North.

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(3) Generally speaking, the Ministry of Transport constructs and operates airports which are served by a scheduled Class I or Class II operator.

Alternative C (lower safety standards)

The final alternative which is open to the Canadian Government in the area of aviation safety in the North is the reduction of safety standards below those in Southern Canada and the cutback on further extension of facilities designed to ensure safer air transport. Both of these avenues appear distasteful to the northern enthusiast but fiscal policies might well create a situation where the Government would be required to reassess its Northern air program and reduce its current rate of expenditures.

It would be extremely unrealistic to foresee any reduction in airworthiness standards or pilot qualifications in Northern Canada below those in Southern Canada. From the social point of view, the argument that human lives are just as valuable in the North as in the South would no doubt prevail and both technical and policy experts would be reluctant to promote the lessening of these safety standards.

With respect to navigational aids, there would also be a great deal of opposition to any move to reduce these networks. If cost reductions became necessary, efforts would probably lean towards the automation or consolidation of the various systems in order to reduce operating costs.

Despite the seemingly unacceptable alternative of decreasing safety standards in the North, there is, surprisingly, considerable pressure on the Ministry of Transport to follow certain unsafe practises. This relates particularly to the development of sub-standard airstrips. This pressure occurs in the Southern as well as in the Northern areas and is usually supported by local officials and others who are not well acquainted with the technical requirements of aviation but are influenced by a normal desire to see their community develop even though it means an inadequate airport. (Possibly too, there is the thought that once the Crown is persuaded to build a sub-standard strip, its very inadequacy will be an additional argument for costly corrective measures to upgrade it.) These pressures are enhanced by the fact that construction of a standard airport is relatively expensive while an airport, to the uninitiated, is an inexpensive operation consisting of clearing a level strip of property and spreading gravel over it. Little thought is given to the obstructions in the flightway, the need for proper drainage, adequate length and width, as well as the need for a firm base. Also of importance is the site itself which should permit expansion if traffic dictates it.

ECONOMIC REGULATION OF AIR CARRIERS

In this area, the Federal Government plays a key role in determining the extent and quality of air service available in the North. The Canadian Transport Commission licenses carriers to operate from specific bases, determines the class of aircraft to be used, determines if route services are in the public interest, selects the carriers for such route operations, determines the need for scheduled operations, accepts tariffs for filing subject to investigation and complaint and recommends subsidies.

Present policies with respect to the North are applied by the Commission in keeping with the overall national policy. In general, special northern policies do not exist, but in the quasi-judicial proceedings which lead up to decisions, there is an opportunity for the special circumstances surrounding any application (in the South or North) to be given considerable weight.

Before considering reasons for maintaining the present policies, or for adjusting them to meet northern requirements, it is necessary to state the possible types of action available. Special policies, not necessarily mutually exclusive, might be developed with respect to the following - the degree of competition to be permitted in the North, the application of subsidies and the initiation of new routes.

Alternative A (same degree of restriction as in Southern Canada)

Degree of Competition - The Government could maintain roughly the same degree of competition in the South as in the North. As there are no "national carriers" (Air Canada and C. P. Air) in the North, the question of parallel operations by these two carriers in the North, as in the South, is not germane. With respect to regional policy, route competition is quite restricted in the South and no doubt at least a similar route services policy in the North is expected by these carriers. Regional carriers whose route structures serve both north and south are now undertaking long-range programs based on a regional policy having broad national significance and they claim that their commitments made in the light of this deserve protection. A somewhat restricted policy for the licensing of any third-level carriers and large charter operators preserves this protection. Competition is limited to small aircraft operators and to a degree which endeavours to ensure their viability at today's level of development.

Subsidies - At present no northern operations receive subsidies, although some are granted on a temporary basis to assist operations in Southern Canada. It has been argued by the northerners that they are being penalized through higher tariff schedules than the southerner, and that through subsidization the cost of northern travel could be reduced to a more equitable basis. To maintain a degree of subsidization equivalent to that in the South, subsidies might be granted for some routes serving small outlying communities which do not have powerful resource investments supporting them.

Initiation of New Routes - Present practise throughout the entire country is for CTC to await submissions of applications for new routes. The industry takes the initiative. This, in general, appears quite adequate and, in view of the many applications that come forward without invitation, many would not favour the Government entering into any promotion campaign in the North. On the other hand, the CTC would not be expected to discourage applications for new routes in the North. The position could well be taken that the industry knows what operations may be viable and apply accordingly.

Conclusions - There are several good reasons for the application of a uniform national policy of economic regulation in both the North and South, including an extension of subsidies in the North in some appropriate form.

Alternative B (less restriction)

Here we must consider the types of alternatives open to the Government to be less restrictive in regulating services in the North than in the South. Again, these will be considered under the same subheadings as in Alternative A.

Degree of Competition

With the need to develop a flexible position to meet any sudden requirement for a rapid expansion of Northern air transport, the Government might find it advisable to permit some extension of present competition with established Regional carriers by other large-aircraft operations. (There are several applications now under review by the Commission which could lead to this.)

Unrestricted entry into new areas by carriers already licensed is another method of meeting emergent needs. This is by no means a new approach and has already been applied. It might for practical reasons be limited to those carriers who now have licensed bases in the North.

A still less restrictive approach would permit the entry of new carriers on an almost completely unrestricted basis and permitting existing licensees to establish new bases in the area of their own choosing. This could be accompanied by the relaxation of all route protection regulations so that carriers would be free to operate charter services over all unit toll routes with any size of aircraft which they have to use. The advantages of this degree of de-regulation are difficult to envisage. Opponents to the proposal would foresee complete chaos in our northern air transport system. Possibly only a national emergency would justify this approach.

Subsidies - A less restrictive policy in relation to competition and economic regulation would militate against a generous policy for subsidization. Subsidies go hand in hand with a "chosen instrument" approach. Where the barriers to competition are lowered, government support must be much more limited. If not public funds would be wasted in supporting competitive enterprises.

Initiation of New Air Routes - Under a freely competitive system, the problem of getting new air services started would not necessarily be minimized. While one might anticipate enterprising operators would propose new routes, they would expect protection which would not be available. New routes would, therefore, be generated in a very uneconomic way, if at all.

Conclusions - Lowering the barriers of competition and the reduction of economic regulation appears to be practical for some limited moves in order to provide adequate services in the event of an "explosion" in arctic development.

Alternative C (more restriction)

Degree of Competition - There is much to be said for more restrictive economic regulation of air transport in the North. The small population to be served and the high costs of labour and materials add considerable risk to commercial operations and also result in higher costs to the user than in Southern Canada. The elimination of all competition could bring about cost reductions through consolidation of sales forces, maintenance bases, administration, etc.

This could be realized through various degrees of consolidation. In the extreme, there could be the consolidation of air route services in the North into one Crown Corporation. (This policy has very significant precedents in the development of transcontinental rail and air services and would constitute a very aggressive attitude to solving northern air problems. It would run completely counter to present Regional carrier policies and could upset the economics of the present network of regional services in the South. The considerations of this or any similar proposal illustrate the interdependence of northern and southern air routes in the present policy).

Subsidies - With limited competition, the case for subsidies for regular services is much enhanced. An aggressive attitude by the Government, through a broad ranging subsidy policy, could lead to provision of modern aircraft along all key routes and what is more important, cheaper transportation for the user with subsequent lowering of living costs throughout the North - a goal particularly popular with Northern residents. The critical feature of this approach is the high cost of such a program which would have to be paid out of the national revenue. Also, subsidies should not run in opposition to surface transportation projects.

Initiation of New Routes - The Government has the opportunity to encourage new routes, particularly an east-west route through Yellowknife, by indicating subsidies are available for non-economic but essential routes - essential for the administration of the North and development of a cohesive Arctic policy. The benefit-cost ratio of such subsidies would have to be examined on an ad hoc basis.

Conclusions - There are cogent reasons for more strict regulation of competition in the North than in the South. This approach would minimize air transport costs to the user and would be complementary to any scheme of subsidization to air carriers.

TRANSPORTATION SUPPORT FACILITIES IN THE NORTH

There are many support facilities required for an air transport system which are not directly related to safety in flight. These are structures and services located at the points of departure and arrival and include such things as passenger shelter, washrooms, cargo and baggage handling, road access and transport to the airport, hotel accommodation, meal services, communications, fuelling and routine maintenance of aircraft, hangars, aircraft parking areas, etc. The following discussion will describe the present national policy with respect to the provision of these, the reasons for the Ministry of Transport maintaining a similar policy

in the North, for taking a less active role or for taking a more active role in providing such facilities.

The national policy leaves to commercial firms the responsibility for providing most support facilities for air transport. The Ministry provides passenger terminal buildings with the usual services at the airports it operates, i.e., where scheduled service is provided, and generally assists muncipalities in doing the same. It also provides parking areas for both aircraft and automobiles. User charges are normally levied to offset the costs of these. However, it does not go beyond this. Airlines are responsible for hangars, fuelling and maintenance of aircraft and cargo and baggage handling. The neighbouring municipality or province supplies the road cost. Transport to and from the airport, meal services, hotel accommodation are all comercial enterprises.

The quality of some of these services in the North varies a great deal, even though this is a critical factor for the comfort and convenience of air travel. In Southern Canada traffic volume, the competitive nature of business and general surveillance by various levels of government ensure that adequate standards are maintained in the supply of these services. However, in Northern Canada, a smaller volume of customers and the resulting lack of competition frequently results in much lower degrees of comfort and convenience.

It is important to emphasize that a concerted effort is made by all those who are financially responsible for the provision of these support services to recover their full costs (plus a profit in the case of commercial services) through user charges.

<u>Alternative A</u> (same degree of Government participation as in the South)

The Federal Government follows its national policy at most northern airports, that is, it leaves to commercial operators the same services as in the South. There are some exceptions, particularly at Resolute Bay, Frobisher Bay and a few other arctic airports where hotel accommodation, meal services, cargo handling, fuelling and/or surface transportation, etc., are provided entirely by or with the assistance of the Ministry of Transport.

However, support facilities throughout the North are more primitive (e.g. , baggage handling, fuelling facilities, surface transport, travel accommodation, etc.). There are no air bridges at Inuvik!

Alternative B (less participation by the Federal Government than in Southern Canada)

If the Ministry of Transport were to withdraw or decrease its support with respect to terminal buildings and associated facilities, the air transport system in Northern Canada would receive a serious blow. The commercial operators would have to step in to fill the vacuum in the absence of local municipal resources; their costs would rise and these would be passed on to their customers. There appears to be no justification for such a discriminatory policy in Northern Canada except that the support services now provided are far from being self-sustaining and result in a higher rate of subsidization per passenger than in the South. This policy could, therefore, be favoured if the overall objective was to minimize subsidies in the process of northern development.

Alternative C (more participation by the Federal Government)

There has always been considerable pressure for the Federal Government to provide more adequate support facilities at northern airports. A recent article in Oil Week[4] complained bitterly of the existing facilities (and prices) at Resolute Bay. At some airports, such as Resolute, the Canadian Air Transportation Administration has provided more services than at others. This is the result of inheriting services formerly provided by the Department of National Defence, or in the case of Arctic Weather Stations, because of the complete lack of commercial activity. "Why", it is argued, "does not the Federal Government prime the pump and reduce costs of northern travel by providing the necessary support facilities at the going-rate in the South?"

Apart from the resources for this, which would come out of general tax revenue, there are other difficulties. Should the travel of employees of large corporations be subsidized in this way? What about tourist travel, hunters from Southern Canada and foreign countries, and so on? If travel is to be subsidized there is reason to restrict this to those who live in the North and this can best be done through payments of "northern living allowances".

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(4) Oilweek, September 14, 1970, page 3.

A more practical avenue for more participation by the Government might be to "spread the butter more thinly", that is, to provide less adequate terminal buildings than in the South but build them at more airports. Also, it might provide some other facilities at lower degrees of comfort and convenience of the type which are now provided by commercial interests in Southern Canada.

CONCLUSION

As stated at the outset, it is not the purpose of this paper to select the most practical alternatives for implementation. Instead, alternatives have been presented against the background of established policy in the South. The cost of any policy must be weighed against the benefits which will accrue from it and these are closely related to the time of any possible explosion of production activity throughout the North. Strategy at least demands that each of these alternatives be examined in the light of this happening at varying dates in the future.

Possibly one principal conclusion can be drawn from the alternative presented. The success of any of these will rest on how efficiently it provides service to the presently small population of northern residents. Many years will elapse before population growth can be sufficient to upgrade the situation so that air transport in the North can be treated in all respects as it is in the South. The challenge then is to recognize this specific problem now and cast policies free from Southern standards wherever necessary - something that is not too evident in air transport today.

ELECTRONIC GUIDANCE IS NOT THE COMPLETE ANSWER

BY: MR. J. MOAR,
Executive Director, Community Planning, Alberta Division

We believe that emergency landing strips, complete with a cabin and emergency supplies, could and should be built at reasonable intervals and at reasonable cost across Northern Canada.

Ordinarily emergency airstrips can be selected from aerial photographs. The Pre Cambrian shield contains hundreds of eskers, many do not require much clearing or levelling to form a landing strip.

These sites can be checked on the ground, cleared and graded for a few thousand dollars apiece. The airstrip at Sawmill Bay on Great Bear Lake was built for $2,000.00. The airstrip at Ft. Franklin for less. The airstrip at Sawmill Bay has saved Eldorado Mining hundreds of thousands of dollars and is now one of the main factors in generating over half a million dollars of tourist business each year on Great Bear Lake. A hundred of these airstrips can be built for what is spent every year for search and rescue. The money spent on search and rescue is mainly wasted, whereas these airstrips would be self liquidating and an increasingly valuable asset.

The mining and tourist business they would generate would help pay for the cost of the airstrips. Equipped with cabins complete with fluorescent strips on the roof clearly marked with signs and numbers they would provide air and ground travellers with a positive check on their location at

all times. Many of these cabins would offer ground parties travelling by dog team, snowmobile or automobile a haven of refuge in storms or other emergencies.

These airstrips could be equipped as campsites along the highways and like the airstrips at Ft. Nelson, Watson Lake in B.C. and High Level in Alberta settlements would grow up around some of them. In many cases where there is a lake or river nearby the cabin can be located on the shore of the lake or river to serve as a shelter for both the personnel using the landing strip or the waterway.

We should not wait until a mineral find is made before building a single landing strip to serve this one isolated location.

We should accept the fact that more and more people are going to want to fly into the north country and to a great extent they are going to be inexperienced. This is going to result in more lost aircraft and more lost lives unless we build these emergency landing strips and make the country easy of access and safe for the private aeroplane to get around in. This holds true for the larger commercial aircraft as well.

We believe that the money spent on these airstrips would do more to assist in the opening up of the mineral wealth and the tourist industry in Northern Canada than any other single investment.

It is assumed that identification signs shown on the cabin roof would enable anyone to locate the airstrip on maps to be made available to Northern travellers. As a personal suggestion I would recommend that the cabins to be built on these airstrips be prefabricated on a 4 x 8 module using native labour at Ft. Smith in the N.W.T., The Pas in Northern Manitoba and places like Moose Factory in the East.

What will the impact of the new aircraft now in production be on the future development of Northern Canada?

Having seen the cost of air freighting in Northern Canada drop from ten dollars a ton mile to fifteen cents a ton mile or less, we should not expect it to stop there. If we accept the criterion of the early bush pilot, that the best is none too good, then the bush pilot of today flies a Lockheed Hercules and tomorrow he will fly a jumbo jet. Figures for jumbo jet freighters of around two cents a ton mile for two-way hauls are being quoted by the manufacturers of these aircraft.

Bell Aerosystems Company of Buffalo consider their new air-cushion landing gear a complete technological break-through in landing systems. When landing the aircraft need not come in contact with the ground until its forward motion has been brought to a complete stop. It can use long stretches of open water, ice, snow, swampland, sand, or dirt for most of its runways; only the terminal area need be hard surfaced. The first test flight using this system has been completed successfully and went off smoothly. Deflated in

flight the A.C.L.C. hugs the bottom of the aircraft without causing aerodynamic drag. The successful use of this A.C.L.C. on large commercial aircraft would open up a new chapter of air transport in Northern Canada.

ARCTIC TRANSPORTATION

BY: MR. J. MOAR
Executive Director, Community Planning, Alberta Division

Having had the chance to study some of the preliminary papers to be presented at your arctic transportation conference, I would like to take this opportunity to express some of the thoughts that come to mind in this connection.

First let me say that the writer is no stranger to this land. When I first landed on Yellowknife Bay in 1930 en route to Coppermine, there was no one living on the north shore of the Bay, not even an Indian. The Indian settlement was on the south shore of the Bay. In later years, I gained experience freighting on the west coast of Hudson's Bay and moving thousands of passengers and thousands of tons of freight by air in and out of Yellowknife.

With the finding of base metals, also gas and oil, on the arctic islands and the arctic coastal areas, the biggest problem facing Canada and Canadians in the 70's and 80's is how do we come to terms with our environment?

Canadians should realize that the two main geographic areas in Canada consist of: (1) the pre-Cambrian shield and; (2) the valleys and lowlands off the edges of this shield.

Man - no matter what his race, or ethnic origins, or what language he uses to communicate - has found that in the lowlands on the edges of the pre-Cambrian shield he can live off the land in relative comfort and prosperity. In the Annapolis Valley, the St. Lawrence lowlands, the Niagara Peninsula, the western Prairies and the Frazer Valley he found the woods full of game and the lakes and streams full of fish; he found plenty of timber for building construction and firewood: and when cleared he found a fertile soil on which he could grow fruits and vegetables, grain and livestock.

Man's efforts in these lowland areas have been rewarded with an abundance of the necessities and amenities of life, with the result that he has populated and developed these areas to the point where some of the older settlements are becoming crowded.

Not so on the pre-Cambrian shield. Whether the shield area lies north of the St. Lawrence Valley, west of the Niagara Peninsula, or east and north of the Prairies, it is almost impossible to live off this land, which consists mostly of rock, water and muskeg.

Practically all the necessities and amenities of life such as food, fuel, shelter and clothing must be imported.

Sure, people enjoy their stay on the pre-Cambrian shield like they do skiing on the slopes of the Rocky Mountains but we can not expect large numbers of people to try and make a living off those rocky slopes the year around: why then should we expect them to do it on the pre-Cambrian shield.

An example which illustrates this point is the eagerness with which the people of Yellowknife await the arrival of the strawberries from the Peace River country in season.

The situation is altogether different in the valleys of the Athabasca, the Peace, the Liard and the Mackenzie. In these valleys we again find good stands of timber - in many cases lush growth of vegetation - and millions of acres of fertile soil as far north as Fort Simpson, with the result that living in these valleys man finds a hospitable environment, whereas on the pre-Cambrian shield, if we are realistic we will admit that the adjectives harsh, cruel, inhospitable, hostile, when applied to the environment are more often than not close to being true.

More than 50,000 people live in relative comfort in the North Peace district of B.C. and in relative prosperity compared to other areas of Canada. More than 60% of them are engaged in farming, ranching, forestry and related industries. A network of roads and railways is being extended in all directions.

Refineries, pulpmills, sawmills, plywood plants and petro chemical plants are either in existence or in the planning stage.

The building of roads or railways in these valleys does not present the problems of rock, muskeg, and water that would be encountered on the pre-Cambrian shield, and when these facilities are built the development of the resources in these valleys should generate sufficient two-way traffic to make the roads and railways economically viable.

Flying along the Mackenzie Highway when it was being built, we watched settlement move north along the highway at the rate of about 10 miles per month, for the first 15 months; then it slowed down to about 5 miles per month for the next 24 months until the soil thinned out to a shallow cover over the limestone, when settlement came to a halt.

It would appear that the building of roads, railroads and pipelines as far down the west side of the Liard and Mackenzie as Fort Simpson is quite feasible with ordinary construction methods used on the Prairies and in B.C.

Because there is no way to stop the settlement (in this land-hungry world) of northern B.C. and the Northwest Territories as far down the Mackenzie as at least Fort Simpson, it would seem sensible to accept these facts in planning the transportation facilities down the Mackenzie River.

Downriver from Fort Simpson we start running into discontinuous permafrost. From Good Hope down it is almost continuous permafrost.

In most areas of Canada we have not been able to improve the environment and we do well if we are able to maintain or protect the environment from further deterioration.

However we have one striking example of where man has improved the environment and that was in the building of the Hudson's Bay Railway.

Here were over 200 miles of impenetrable bog or muskeg underlain with permafrost which could only be navigated by canoe or dog team. Man has built and operated a railway across this bog for more than 40 years with no damage to the ecology or environment. The moose, deer and caribou cross this railway grade at will, and find this railway grade a good game trail or path to follow.

Many people say, "Oh yes, we intend to use and benefit from the experience acquired in the building of the Hudson's Bay Railway", but as Dr. Trevor Lloyd stated, "The existence and availability of knowledge does not guarantee that it will be used."

He illustrated this by remarking that when the Americans came to establish Camp Canol on the west side of the Mackenzie River, they stripped the overburden and within a week found the campsite had turned into a sea of mud. They backed off and located the camp several miles away on a gravel bench. Had they made use of the knowledge gained by the building of the Hudson's Bay Railway they would have saved themselves a lot of money and inconvenience.

To date the furthest the oil and gas industry and the ecologists seem to have gone in the study of the successful building of the Hudson's Bay Railway is to accept the fact that man can traverse muskeg and tundra in the winter time using tracked vehicles with little damage to the permafrost.

Few people seem to have grasped the significant fact that a railway is one of the best load spreading devices we know and that it can be laid on top of the snow in the winter time. Fastening the rails to every third tie only, and using bottom dump cars, gravel can be dumped on top of the snow; and then the tracks and ties can be lifted so that the gravel falls through between the rails. This forms a gravel pad on top of the snow and permafrost which insulates the permafrost and keeps it eternally frozen.

The main object in writing this screed is the hope that someone in authority will insist on writing into the specifications for the building of roads, railroads or pipelines on permafrost the requirement that some similar techniques be adopted in their construction.

AIR TRANSPORT 1970 - STATUS & REQUIREMENTS
BY: THE GOVERNMENT OF THE NORTHWEST TERRITORIES

HISTORICAL NOTE

Half a century ago, bush pilots like Wop May and Archie McMullen of Commercial Airways began to rip open the shroud of silence, mystery and romance which blanketed the Northwest Territories.

Mineral exploration was their principal goal and mining companies most often footed the bill. Thus Matt Berry entered the northern flyers' hall of fame under the banner of Northern Aerial Mineral Exploration, flying out of Sioux Lookout. Stan McMillan and Bill Spence got into the action in the 20's for Dominion Explorers. Western Canada Airways, later Canadian Airways, assaulted the new frontier with captains Leigh Brintnell, Punch Dickens, Conn Farrell, Walter Gilbert, "Westy" Westergaard, and again Stan McMillan.

Also among those commemorated by the Bush Pilots' Memorial, a National Historic Site high above Yellowknife's "old town", are Bill Jewitt and Mike Finland who flew for Cominco in the 20's.

Mackenzie Air Services brought McMillan, Brintnell, Berry and Harry Hayter together in northern service in the 1930's.

The exigencies of World War II gave an immense impetus to northern air transport and facilities, including construction of the Northwest Staging Route airstrips now in civil use. The Canol Project, development of uranium at Port Radium and ultimately, the DEW Line, were contributing projects. Meanwhile, in 1942, Canadian Pacific Airlines took over from all other scheduled commercial carriers on the Mackenzie route.

Pacific Western Airlines obtained this main line monopoly from CPA in 1959, still operating the DC-3 among its regular passenger carriers into the North from Edmonton. Pacific Western introduced the first scheduled Edmonton-Yellowknife jet service in December, 1968, extending shortly afterward to Inuvik, Cambridge Bay and Resolute.

Baffin Island's early charter services from Montreal by Dorval Air Transport, Wheeler Airlines, and later Wheeler Northland Airways Ltd., were not overtaken by scheduled operations until Nordair Ltd. began a Class 3 service in 1957. By 1960, this Montreal-Frobisher flight was much more dependable, using the DC-4. Jet service to Frobisher was inaugurated in December, 1968, and extended to Resolute in May, 1969, after certification of the Boeing 737 for gravel strips.

In the central northern air corridor, all operations of what now is Transair Ltd. prior to 1956 were carried out under charter licences only, by Central Northern Airways Ltd. Most of the flying was in support of DEW Line construction. In 1956, Central Northern merged with Arctic Wings Ltd., which has been operated out of a protected charter base at Churchill by the Roman Catholic Church to re-supply its Arctic missions.

Transair Ltd. was the result of the merger. It held onto the Arctic Wings licence and gradually introduced Class 2 and 3 services to Rankin Inlet, Baker Lake and Coral Harbour, adding other communities with the growth of airstrip and ground support services.

Transair took over the Manitoba division of CPAL in the Fall of 1957, introducing a scheduled Winnipeg-Churchill service. and a Class 2 service from Montreal and Ottawa to Churchill via Winisk, on the Mid Canada radar Line. This latter service was discontinued in 1966 following Mid Canada Line phase out in 1965.

A Churchill-Yellowknife service was operated from November, 1968 until July, 1969.

Transair inaugurated its YS-11 turbo-prop service Winnipeg-Churchill in September 1968.

Today, scheduled services supplementing these South-North corridor routes from Montreal, Winnipeg and Edmonton are operated by nine other carriers. They are: Northwest Territorial Airways Ltd.; Reindeer Air Service Ltd.; Arctic Air Ltd.; Ptarmigan Airways Ltd.; Atlas Aviation Ltd.; Wheeler Northland Airways Ltd.; and Austin Airways Ltd.

In addition, these and other companies provide a variety of charter services across the Northwest Territories.

AIR TRANSPORT NEEDS OF NORTHERN RESIDENTS

Introduction

In considering the transportation needs of residents of the far north, there are two realities which must constantly be kept in mind.

The first is the vastness of the country. The 35,000 residents of the Northwest Territories are scattered over 34% of Canada. The north-south distance from the north coast of Ellesmere Island to the 60th parallel is greater than from the 60th parallel down to San Francisco. Or, taking the extreme limits of the Territories, from Ellesmere down to the islands in James Bay is the same as from James Bay to Mexico City. Projecting down from the western and eastern limits, we go from 600 miles west of Vancouver to 120 miles east of Halifax.

The other reality is that in the Canadian North people are more dependent on air transport than anywhere else in the world. This is the country where the bush pilot made such an impact in the very early days of aviation, and where the bush pilot is still a very important part of our way of life. Only 46% of the people of the Northwest Territories, those concentrated in the south-west corner, have road access. Even they are highly dependent on air services; distances are great, and for most of these people the road connection is interrupted for a month Spring and Fall during break-up and freeze-up. The 54% who are without road access have only air service, except for the freight shipments which come in by water during the short navigation season.

Facilities Needed

Before we can have adequate air services, we must have adequate airstrips and related facilities. Considerable progress has been made in this regard in recent years and construction is continuing, but some pressing needs are still to be met.

<u>The most basic requirement is for reasonably continuous access to all communities.</u> There are still 2800 people in 14 communities who are totally isolated for weeks or even months at a time during break-up and freeze-up. We know of cases where Northern Health Service have been faced with a medical emergency. They have gone the rounds of the carriers in the hope of being able to evacuate a patient from a settlement, and there has been nothing the carriers could do. Usually, there is not a helicopter close enough

to respond to emergencies of this type.

However, the need goes beyond emergency access. A real need in each settlement is for a strip which will handle the largest aircraft that traffic to the community can reasonably justify. Ton-mile costs for air freight are of course extremely sensitive to aircraft size. When shipping goods more than 300 miles by Twin Otter because nothing larger can land at the destination -- and this is done -- anything that comes off that aircraft is going to be a high cost item. The effect on the cost of living is obvious. High transportation costs also act as a deterrent to the economic development which is so urgently needed in the Territories. The costs are highest in the more remote settlements, where the people and the economy are least able to carry the extra burden. The type of airstrip which can be justified will depend on the size of the community and its level of activity. For those centres which are or should become major distribution points, the target should be a 5,500-foot strip suitable for a Hercules, and in most cases for a Boeing 737.

More adequate navigational aids are needed, both for enroute navigation and for landing. Here again improvements are being made. However, it is still very common to be out of range of a beacon for considerable distances, in a country where the magnetic compass is unreliable or useless and where there are few landmakrs for visual navigation. Much of the tundra is flat and so uniformly white that it is difficult to tell land from ice. A program of increasing the power of beacons throughout the Northwest Territories would go far toward assuring safe, reliable operations. Replacements and new installations should incorporate Visual Omni Range equipment. The VOR beacon is the most reliable alternative to the Non Directional Beacon, and has many advantages, being unhampered by snow static, refractions and other difficulties.

Better communications facilities between communities are urgently needed, for improved transportation as well as for other purposes. It often happens that an aircraft will fly to its destination and find it below limits, because the local weather could not be obtained before take-off. Also people in the community have no way of knowing whether or when a flight is coming. Apart from weather limitations, many of our services are operated under a Class 3 licence and flights are subject to change or cancellation, so better flight information is needed.

Services Needed

With regard to services, the first need is for a scheduled

or unit toll operation into every community where the potential traffic can reasonably justify it. With the new services which have been brought in during the last few years, this ideal has now almost been realized. In the entire Northwest Territories there are only three off-highway settlements with a population of over 75 that do not have some form of scheduled air service. On the Belcher Islands, a 1,500-foot strip has recently been completed. A strip is required at Port Burwell, and, hopefully scheduled services will follow at both places. The third location, Lac La Martre, is close to Yellowknife and is fairly adequately served by charter aircraft.

A second need is for an East-West route to augment the existing services. As would be expected, the present network of air routes follows the pattern of greatest traffic flow. There are three main north-south arteries -- from Edmonton to the Mackenzie Basin and north, from Winnipeg to Churchill and the Keewatin, and from Montreal to Baffin Island and north. Local services fan out to the settlements from points on these arteries. However, to get from the capital at Yellowknife to the administrative centre of the Eastern Arctic at Frobisher Bay, it is necessary to spend one night in a hotel in Edmonton and the next night in a hotel in Montreal. If the vast area of the Northwest Territories is to be welded into one political, social, and economic unit, an East-West service is essential. Indications are that some Government encouragement will be required at the beginning, but that in time sufficient traffic should build up to make the service independently viable.

At the present stage of Territorial development, charter services are extremely important. A wide variety of aircraft are needed, depending on the type and amount of traffic to be carried, on the distances involved, and on the airstrips available. There are many charter companies providing good service, but in several centres the selection of aircraft available is still not great enough to satisfy the demand.

There are other less tangible services needed by people who are so dependent on their air carrier. To do his job adequately, the carrier has to feel and show a degree of personal concern for the people in the area he serves. This shows up in a variety of ways -- in the handling of special and perishable shipments, in the extent to which customers are kept informed of flights, in the courtesy extended to passengers and shippers, and so on. The degree to which these needs are met varies throughout the Territories, and freezing and spoilage of high-cost perishables is a very real problem in some areas. Carriers often do not enjoy the esteem their general operations warrant, because of insufficient attention to these seemingly minor matters.

Changes are taking place rapidly in the far north, and these changes affect the nature of the economy and the way of life. While the general needs outlined above will persit, specific needs will change and new ones will arise. It is important that our whole system of air transport be flexible enough to be responsive to these changes.

Balance Between Air and Surface Freight

In addition to the problems already discussed, the Territories have a broader problem in moving freight into and within the off-highway regions.

Most materials and supplies for Arctic residents now go by ship or barge. The direct ton-mile cost is lower than it would be for any other method of transport. However, with the short navigation season, everything must be ordered by Spring, and building materials arrive at their destination at the end of the good construction weather. There are substantial hidden costs in loss of flexibility, inefficiency, and wastage, and the development of the Territories is to some extent impeded.

The remaining material goes by air, either because it is perishable or because of the scheduling limitations of water transport. However, because the amount is small, and sometimes also because of airstrip limitations, much of it goes by smaller aircraft at very high cost.

The need is obviously to strike an optimum balance between sea and air transport, and to break the "chicken and egg" type of deadlock where the quantities moving by air are too small to permit a low enough cost structure to attract higher quantities. This deadlock has been broken to a considerable extent on some routes, but much remains to be done. Study and action by both the customers and the air transport industry are required.

RECOMMENDED FACILITIES

FOR GROUND SUPPORT TO AIR TRAFFIC

NORTHWEST TERRITORIES

DECEMBER 1970

I. AIRSTRIP CONSTRUCTION
II. NAVIGATIONAL AIDS

LISTED ACCORDING TO PRIORITIES AS FOLLOWS:

AA
A
AB
B
C

I. AIRSTRIP CONSTRUCTION

(N.B. - A number of minor construction and improvement projects which can be carried out through N.W.T. Government resources, are not included in this list).

PRIORITY AA

	Community	Requirement
1.	Fort McPherson:	A good 3,000-foot strip. McPherson is an important development centre and is inaccessible for 3-4 weeks in the Spring.
2.	Port Burwell:	An 1,800-foot strip. Construction will be difficult and an investigation is required to determine the site and establish the cost. Burwell is totally inaccessible for prolonged periods in Spring and Fall, and is inaccessible from Frobisher Bay all Summer since no float planes are available there.
3.	Lake Harbour:	An 1,800-foot strip. An investigation is required, since no good site is apparent close to the settlement. Lake Harbour now is totally inaccessible during June, and the only summer strip is a natural sandbar reached from the settlement by boat. The terrain prohibits vehicular traffic from the summer strip to the settlement, due to near-vertical cliffs.

PRIORITY A

	Community	Requirement
4.	Snowdrift:	An 1,800 to 3,000-foot strip.

PRIORITY A (Continued)

	Community	Requirement
5.	Whale Cove:	A 3,000-foot strip.
6.	Pelly Bay:	Complete up-grading to provide an all-weather 5,500-foot strip.

PRIORITY AB

	Community	Requirement
7.	Cape Dorset:	Remove hump from strip and up-grade to 3,000 or 5,500 feet.
8.	Arctic Red River:	An 1,800-foot strip. Arctic Red now is inaccessible for 2-3 weeks in Spring.
9.	Rae Lakes:	At least an emergency strip. If the settlement is to persist, it should have an 1,800-foot all-weather strip. Construction is not expected to be difficult.
10.	Belcher Islands:	A 1,500-foot strip has been completed recently. This should be extended to at least 1,800 feet. Material is available locally.

PRIORITY B

	Community	Requirement
11.	Pond Inlet:	If Pond Inlet is to become a distribution centre for the Eastern high Arctic, a 5,500-foot strip suitable for jet traffic should be provided. Developments at Mary River may affect this decision.

PRIORITY B (Continued)

Community	Requirement
12. Arctic Bay:	A new strip which could be used in total darkness, probably about four miles down the Bay. The community now is inaccessible from mid-November to mid-December.
13. Grise Fiord:	A new strip which could be used in total darkness, probably farther up the slope, with an approach angle less directly into the cliff.
14. Rankin Inlet:	Due to its strategic location in the Keewatin, Rankin should have a 5,500-foot strip suitable for jet traffic.

PRIORITY C

Community	Requirement
15. Fort Reliance:	A 3,000-foot strip to serve as an emergency alternate and as a base for operations in the area.
16. Eskimo Point:	A cross-strip to the present one, or re-location. The existing strip is in a cross-wind situation. Length should be 3,600-4,000 feet.
17. Trout Lake:	Provide STOL strip. Likely only a small expenditure required.
18. Aklavik:	Re-locate strip or protect from flooding.
19. Holman Island:	Eventually it may be desirable to re-locate so the strip is not in the centre of the settlement.

II. NAVIGATIONAL AIDS

PRIORITY A

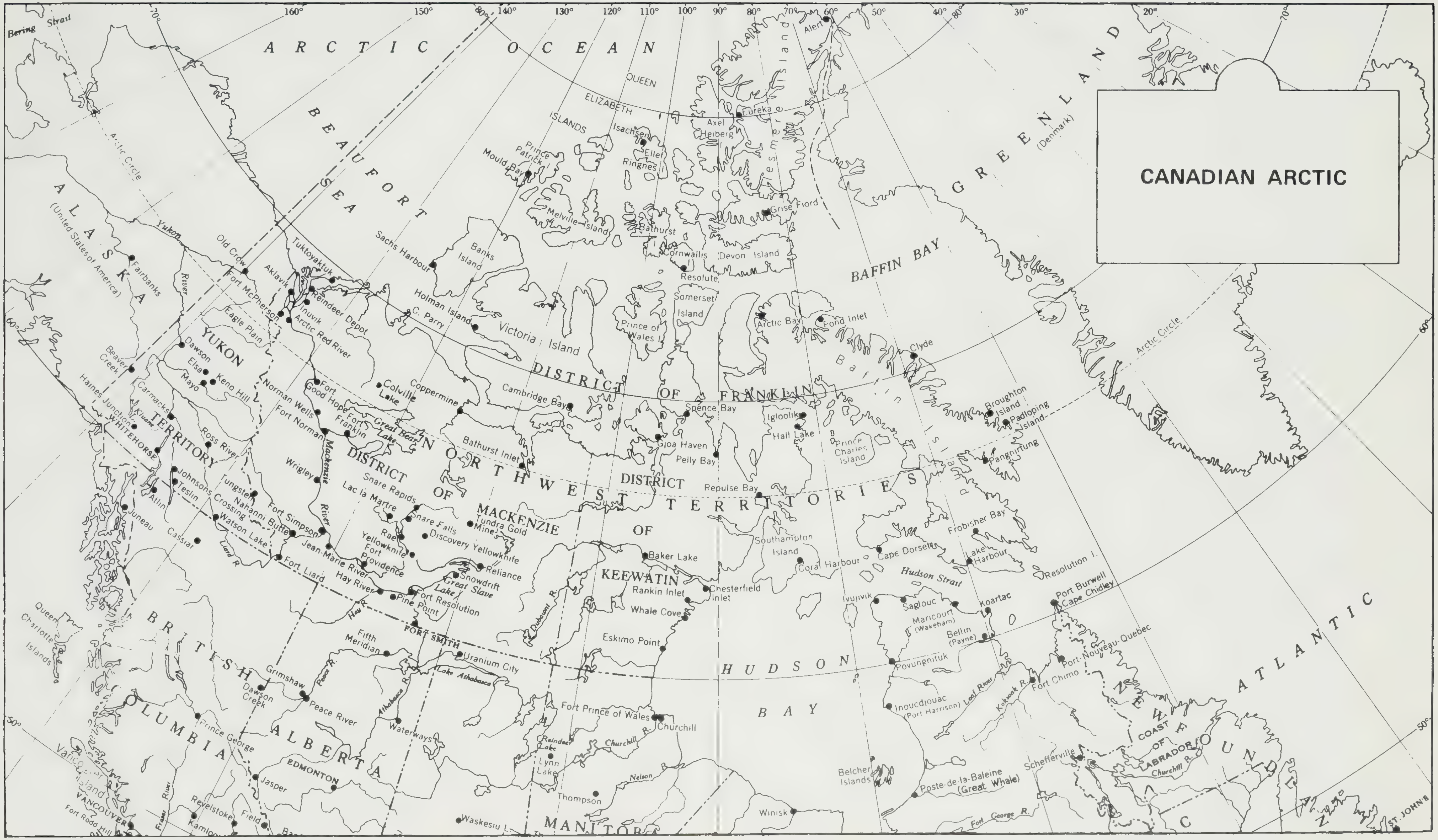
	Community	Requirement
1.	Resolute Bay:	Instrument Landing System (ILS).
2.	Frobisher Bay:	Visual Omni Range beacon (VOR) or alternate means of filling the gap between Frobisher and Hall Beach.
3.	Hall Beach:	Visual Omni Range beacon (VOR).
4.	Baker Lake:	More powerful beacon.
5.	Repulse Bay:	More powerful beacon.
6.	Port Radium:	Beacon to replace under-powered one operated by N.W.T. Air.
7.	Holman Island:	Beacon.
8.	Belcher Islands:	Beacon.

PRIORITY B

	Community	Requirement
9.	Between Fort Reliance and Baker Lake:	Beacon, with air to ground and hourly weather. Extent of need will depend on effectiveness of the new beacon at Reliance and the more powerful beacon recommended for Baker Lake.
10.	Resolute Bay:	Visual Omni Range beacon (VOR).
11.	Cambridge Bay:	Visual Omni Range beacon (VOR).

PRIORITY B (Continued)

	Community	Requirement
12.	Cambridge Bay:	Instrument Landing System (ILS).
13.	Whale Cove:	More powerful beacon.
14.	Rankin Inlet:	Ground weather station.


CANADIAN ARCTIC
ARCTIC OCEAN
BEAUFORT SEA
QUEEN ELIZABETH ISLANDS
GREENLAND (Denmark)
BAFFIN BAY
Baffin Island
Ellesmere Island
ATLANTIC
HUDSON BAY
Hudson Strait
DISTRICT OF FRANKLIN
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
DISTRICT OF KEEWATIN
YUKON TERRITORY
ALASKA (United States of America)
BRITISH COLUMBIA
ALBERTA
MANITOBA
NEWFOUNDLAND
COAST OF LABRADOR
Bering Strait
Arctic Circle
Alert
Eureka
Axel Heiberg
Isachsen
Ellef Ringnes I.
Prince Patrick I.
Mould Bay
Melville Island
Bathurst I.
Grise Fiord
Cornwallis I.
Devon Island
Resolute
Somerset Island
Prince of Wales I.
Arctic Bay
Pond Inlet
Clyde
Broughton Island
Padloping Island
Pangnirtung
Igloolik
Hall Lake
Prince Charles Island
Spence Bay
Gjoa Haven
Pelly Bay
Repulse Bay
Southampton Island
Coral Harbour
Cape Dorset
Frobisher Bay
Lake Harbour
Resolution I.
Port Burwell
Cape Chidley
Koartac
Saglouc
Maricourt (Wakeham)
Bellin (Payne)
Ivujivik
Povungnituk
Inoucdjouac (Port Harrison)
Leaf River
Koksoak R.
Fort Chimo
Port-Nouveau-Quebec
Schefferville
Churchill R.
Belcher Islands
Poste-de-la-Baleine (Great Whale)
Fort George R.
Winisk
ST. JOHN'S
Banks Island
Sachs Harbour
Victoria Island
Holman Island
C. Parry
Cambridge Bay
Bathurst Inlet
Coppermine
Colville Lake
Great Bear Lake
Fort Franklin
Fort Good Hope
Norman Wells
Fort Norman
Mackenzie River
Wrigley
Fort Simpson
Tungsten
Nahanni Butte
Snare Rapids
Lac la Martre
Snare Falls
Rae
Yellowknife
Fort Providence
Discovery Yellowknife
Tundra Gold Mines
Reliance
Snowdrift
Great Slave Lake
Fort Resolution
Pine Point
Hay River
Jean Marie River
Fort Liard
Liard R.
Hay R.
FORT SMITH
Fifth Meridian
Uranium City
Lake Athabasca
Athabasca R.
Waterways
Peace R.
Peace River
Grimshaw
Dawson Creek
Prince George
Jasper
EDMONTON
Revelstoke
Field
Kamloops
Fraser River
VANCOUVER
Vancouver Island
Fort Rodd Hill
Queen Charlotte Islands
Baker Lake
Chesterfield Inlet
Rankin Inlet
Whale Cove
Eskimo Point
Dubawnt R.
Fort Prince of Wales
Churchill
Reindeer Lake
Lynn Lake
Nelson R.
Thompson
Waskesiu L.
Tuktoyaktuk
Reindeer Depot
Inuvik
Aklavik
Arctic Red River
Fort McPherson
Old Crow
Eagle Plain
Dawson
Elsa
Keno Hill
Mayo
Yukon River
Fairbanks
Beaver Creek
Carmacks
Kluane
Haines Junction
WHITEHORSE
Ross River
Johnsons Crossing
Teslin
Atlin
Watson Lake
Juneau
Cassiar
160°
150°
140°
130°
120°
110°
100°
90°
80°
70°
60°
50°
40°
30°
20°